AUG 31 1922

JULY, 1922 NO. 32

JOURNAL OF THE INSTITUTION OF PETROLEUM TECHNOLOGISTS

AND

RECORD OF TRANSACTIONS.

FOUNDED 1913—INCORPORATED 1914.

PUBLISHED BY
THE INSTITUTION OF PETROLEUM TECHNOLOGISTS,
5, JOHN STREET, ADELPHI, STRAND, LONDON, W.C. 2,
AND PRINTED BY
W. SPEAIGHT AND SONS, LTD.,
98–99 FETTER LANE, LONDON, E.C. 4.

PRICE 7s. 6D.

All rights of Publication or Translation are reserved.

W. J. FRASER & Co., Ltd

ENGINEERS, DAGENHAM, ESSEX, ENGLAND

Complete Oil Distilling and Refining Plant Manufactured and Erected

ALL SIZES AND TYPES OF:

STILLS	AGITATORS
RETORTS	COOLERS
DEPHLEGMATORS	HEAT EXCHANGERS
CONDENSERS	TANKS, ETC.

CONSTRUCTED FOR ANY SPECIAL REQUIREMENT

Send for Catalogue, Section 10, J. P. T.

LIST OF THE OFFICERS

OF

The Institution of Petroleum Technologists,

1922-1923.

Past Presidents:

*Sir Boverton Redwood, Bart., D.Sc., F.R.S.E. (1914-1916).
Prof. Sir John Cadman, K.C.M.G., D.Sc., M.Inst.C.E. (1916-1917).
Sir Charles Greenway, Bart. (1917-1919).
Sir Frederick W. Black, K.C.B., B.A. (Lond.) (1919-1921).

President:

Professor John Samuel Strafford Brame, F.I.C., F.C.S.

Vice-Presidents:

Herbert Barringer, M.Inst.C.E., M.I.Mech.E., M.I.N.A.
Sir George Beilby, LL.D., F.R.S.
The Rt. Hon. Viscount Cowdray of Cowdray.
Arthur W. Eastlake, M.I.Min.E., A.M.I.Mech.E.
Sir Thomas H. Holland, K.C.S.I., K.C.I.E., D.Sc., F.R.S.

Members of Council:

Alfred C. Adams.
Herbert Allen.
Major R. W. Barnett, M.P., M.A.
Andrew Campbell, F.I.C., F.C.S.
Sir John T. Cargill, Bart.
A. E. Chambers, A.M.Inst.C.E.
E. H. Cunningham Craig, B.A., F.R.S.E., F.G.S.
Alexander Duckham, F.C.S.
A. E. Dunstan, D.Sc., F.I.C., F.C.S.
James Kewley, M.A., F.I.C., F.C.S.
W. R. Ormandy, D.Sc., F.I.C., F.C.S., M.I.A.E.
T. C. Palmer, A.M.Inst.C.E.
F. Mollwo Perkin, C.B.E., Ph.D., F.I.C., F.C.S.
Robert Redwood, F.C.S.
Prof. W. W. Watts, F.R.S., D.Sc., M.A., Hon. LL.D., F.G.S

Honorary Treasurer: Sir William Plender, G.B.E.
Honorary Solicitors: Messrs. Ashurst, Morris & Crisp.
Honorary Auditors: Messrs. Price, Waterhouse & Co.

*Deceased.

Bankers:

LONDON COUNTY WESTMINSTER AND PARR'S BANK, LIMITED, 21, Lombard Street, London, E.C. 3.

Hon. Editor:

A. E. DUNSTAN, D.Sc., F.I.C., F.C.S.

Hon. Secretary:

ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.

Secretary and Librarian:

Commander R. E. STOKES-REES, R.N.

Offices—5, John Street, Adelphi, Strand, London, W.C. 2.

COMMITTEES.

ELECTION, FINANCE, PUBLICATION AND STANDARDIZATION.

Members of the Election Committee.

Prof. J. S. S. BRAME, F.I.C., F.C.S. (*ex officio*).
Prof. Sir JOHN CADMAN, K.C.M.G., D.Sc., M.Inst.C.E.
ANDREW CAMPBELL, F.I.C., F.C.S.
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.
Sir THOMAS H. HOLLAND, K.C.S.I., K.C.I.E., D.Sc., F.R.S.
JAMES KEWLEY, M.A., F.I.C., F.C.S.
W. R. ORMANDY, D.Sc., F.I.C., F.C.S., M.I.A.E.
T. C. PALMER, A.M.Inst.C.E.

Members of the Finance Committee.

ALFRED C. ADAMS (*Chairman*).
Prof. J. S. S. BRAME, F.I.C., F.C.S. (*ex officio*).
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.
T. C. PALMER, A.M.Inst.C.E.
ROBERT REDWOOD, F.C.S.

Members of the Publication Committee.

HERBERT BARRINGER, M.Inst.C.E., M.I.Mech.E., M.I.N.A.
Prof. J. S. S. BRAME, F.I.C., F.C.S. (*ex officio*).
Prof. Sir JOHN CADMAN, K.C.M.G., D.Sc., M.Inst.C.E.
E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S.
A. E. DUNSTAN, D.Sc., F.I.C., F.C.S.
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.
JAMES KEWLEY, M.A., F.I.C., F.C.S.
W. R. ORMANDY, D.Sc., F.I.C., F.C.S., M.I.A.E.
F. MOLLWO PERKIN, C.B.E., Ph.D., F.I.C., F.C.S.

Members of the Standardization Committee.

Prof. J. S. S. BRAME, F.I.C., F.C.S. (*ex officio*).
ALEXANDER DUCKHAM, F.C.S. (*Chairman*).
A. E. DUNSTAN, D.Sc., F.I.C., F.C.S.
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E. (*ex officio*).
JAMES KEWLEY, M.A., F.I.C., F.C.S.
W. R. ORMANDY, D.Sc., F.I.C., F.C.S., M.I.A.E.
ROBERT REDWOOD, F.C.S.

Co-opted Members of the Standardization Committee.

Admiralty—Eng.-Capt. W. M. WHAYMAN, C.B.E., R.N.
Government Laboratory—J. J. FOX, O.B.E., D.Sc., A.I.C., F.C.S.
National Physical Laboratory—W. F. HIGGINS, F.Ph.S., A.R.C.Sc.
Petroleum Department—J. L. JEFFERY, A.R.S.M., M.Inst.M.M.
Air Ministry—Dr. RUDORF.
War Office—W. L. BAILLIE.
ARTHUR A. ASHWORTH, M.A., A.M.Inst.C.E.
R. G. BATSON.
S. E. BOWREY, B.Sc.
E. A. EVANS, F.C.S.
F. H. GARNER, Ph.D.
J. E. HACKFORD, B.Sc., F.I.C., F.C.S.
PETER KERR.
E. LAWSON LOMAX, M.Sc., F.C.S.
W. LEE.
A. G. MARSHALL.
T. M. MACKENZIE, A.I.C., F.C.S.
ARNOLD PHILIP, B.Sc., A.R.S.M., F.I.C., F.C.S.
P. E. SPIELMANN, Ph.D., F.I.C., B.Sc., A.R.C.Sc
F. B. THOLE, D.Sc., F.I.C., F.C.S.
H. T. TIZARD.
W. J. WILSON, A.I.C.
W. A. WOODROW.

CONTENTS.

	PAGE
Council and Officers..	i.–ii.
Committees	ii.–iii.
General Notices :—	
Copyright	vi.
Issue of Journal	vi.
Changes of Address	vi.
To Authors of Papers	vi.–vii.
Communications	vii.
Appointments Register	vii.
Library	vii.–x.
Advertisements in the Journal	x.
List of Advertisers	x.
Personal Notes of Members and Special Notices ..	xi.
Price of Journals	xi.
Annual Report of the Council, 1921	269–275
Fourth Annual Dinner, 1922	276–291
Ninth Annual General Meeting	292–300
Presidential Address, Prof. J. S. S. BRAME	300–311
Sixty-third Meeting :—	
Galicia and its Petroleum Industry, by ALBERT MILLAR, A.M.I.Mech.E.	311–340
Discussion :—Sir T. H. HOLLAND, Mr. G. W. HALSE, Mr. C. DABELL, Prof. MADGWICK, Dr. J. A. L. HENDERSON, Mr. F. G. RAPPOPORT and Mr. E. A. EVANS	340–348

Sixty-fourth Meeting :—

Kukkersite, the Oilshale of Esthonia, by E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S. .. 349–359

Discussion :—The President, Prof. WATTS, Dr. PERKIN, Mr. S. HUTCHINS, Mr. H. NIELSON, Mr. P. REUSS, Mr. G. PITT, Mr. EVANS and Mr. G. HOWELL 359–371

Written Contributions from Mr. A. B. THOMPSON, Prof. MADGWICK and Mr. J. ROMANES 371–375

Written Communication :—

Petrols for Road Vehicles and Aircraft, by OLIVER THORNYCROFT, O.B.E., B.A. 376–396

Correspondence 396–398

Reviews 399–400

Current Bibliography, compiled by W. J. WILSON, A.C.G.I., A.I.C. 401–430

American Chemical Society. Abstracts of Papers .. 431–433

Abstracts, compiled by S. BOWMAN, A.I.C. 434–464

• • •

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

NOTICES.

The Institution as a body is not responsible for the statements of opinions expressed in any of its publications.

Copyright. The entire contents of the Journal are covered by general copyright, and official permission is necessary for reprinting long abstracts; but editors may use not more than three pages of any paper, provided that credit is given as reproduced from the Journal of the Institution of Petroleum Technologists or advance-proofs thereof.

Issue of Journal. The Journal appears in four parts per sessional volume, viz., in January, April, July and October. A brochure describing the origin, progress and purposes of the Institution, and comprising also the Memorandum and Articles of Association, the By-Laws and Regulations of the Institution, the Library Catalogue to date (with subject index), and the List of Members, was published in September, 1915, to be followed periodically by revisions of the Library Catalogue and List of Members. The List of Members brought up to March, 1922, is now issued.

Members of all classes are entitled to receive these publications free; for additional copies of the Journal they will be charged at the price of seven shillings and sixpence per part, and of the brochures at the prices stated on the wrappers, varying in proportion to bulk.

Changes of Address. It is particularly requested that members notify the Secretary immediately of any change of address; and members are also requested to advise the Parcel Post Department, as well as the Letter Office, of any temporary change of address, as, unless this is done, parcel post packets will not be re-addressed, but will be returned to the offices of the Institution in London, thus incurring further expense for postage.

To Authors of Papers. Papers should be written in the third person and the copy should be carefully corrected by the author before it is presented.

All drawings, diagrams or other illustrations should be sent in a fit state for direct photographic reproduction.

All quotations, technical terms and localisms should be indicated by means of inverted commas.

Foreign weights, measures and costs should be given whenever possible, and also their English equivalents.

It is suggested that authors append as complete a bibliography of the subject treated as may be possible.

All papers and notes submitted to the Institution are supposed to be original communications unless distinctly stated to be otherwise, in which case the exact reference to the previous publication should be given.

Communications upon papers read at meetings, notices of personal movements, or other matter for which publication is desired in the next issue of the Journal, should be in the hands of the Editor on or before the last day of December, March, June or September, as the case may be. Subsequent delivery may be too late for insertion.

The Council desire to draw the attention of authors to the serious increase in the cost of production. Papers, both for the Journal and for communication to the Institution, should be as concise and condensed as possible.

Communications. The Council invite members to submit papers for the forthcoming session. Communications to the Institution will, subject to the approval of the Publication Committee, be published in the Journal.

Appointments Register. A Register will be kept at the offices of the Institution for the convenience of firms requiring the services of members and for members requiring appointments, but on the distinct understanding that the Institution accepts no responsibility and gives no guarantee.

Library. The Institution's Library at No. 5 John Street, Adelphi, may be consulted between 11 and 4 daily. Extensive additions are being made to the current and standard literature on Petroleum.

Additions since publication of last Journal :—

Oil Encyclopedia. By Marcel Mitzakis.

Nonbenzenoid Hydrocarbons. By Dr. Benjamin T. Brooke, Ph.D.

Power Alcohol as a Fuel for Egypt. By Cecil W. Wood, A.I.C., etc.

Smorjningsa Problemet. Av Evert Norlin.

Distillation Principles and Processes. By Sydney Young.

From the Imperial Mineral Resources Bureau :—

The Mineral Industry of the British Empire and Foreign Countries. War Period (1913–1919). Volumes on Coal, Coke and By-Products, Part II.; Copper; Gold; Lead; Mica; Platinum and Allied Metals; and Tin.

Iron Ore. (Summary of information as to the present and prospective iron-ore supplies of the world.) Part I.—United Kingdom.

Laws and Regulations Relating to Lead Poisoning. (Being an analysis, with texts, of the Laws and Regulations made in the chief industrial countries to prevent plumbism.) By Gilbert Stone.

Third Annual Report of the Governors of the Imperial Mineral Resources Bureau, 1921. (In duplicate.)

From the Department of the Interior, U.S. Geological Survey :—

Bulletin No. 200. Evaporation Loss of Petroleum in the Mid-Continent Field. By J. H. Wiggins.

Bulletin No. 207. The Analytical Distillation of Petroleum and Its Products. By E. W. Dean, H. H. Hills, N. A. C. Smith, and W. A. Jacobs.

Bulletin No. 725J. Ore Deposits of the Sierra Mountains, Pima County, Arizona. By F. L. Ransome.

Bulletin No. 726D. Lignite in the Western Part of the Fort Berthold Indian Reservation, South of Missouri River, North Dakota. By Clyde Max Bauer and Frank A. Herald.

Bulletin No. 726E. Geologic Structure of Parts of New Mexico. By N. H. Darton.

Bulletin No. 726F. Geologic Structure and Oil and Gas Prospects of a Part of Jefferson County, Oklahoma. By Heath M. Robinson.

Bulletin No. 726G. The Lacasa Area, Ranger District, North-Central Texas. By Clarence S. Ross.

Bulletin No. 735A. The Candelaria Silver District, Nevada. By Arnold Knopf.

Bulletin No. 735B. Colemanite in Clark County, Nevada. By L. F. Noble.

Bulletin No. 735C. Bonanza Ores of the Comstock Lode, Virginia City, Nevada. By Edson S. Bastin.

Professional Paper No. 129C. Graphic and Mechanical Computation of Thickness of Strata and Distance to a Stratum. By J. B. Mertie, Jr.

Professional Paper No. 129D. Stratigraphic Sections in South-Western Utah and North-Western Arizona. By John B. Reeside, Jr., and Harvey Bassler.

Professional Paper No. 129E. The Byram Calcareous Marl of Mississippi and its Foraminifera. By C. Wythe Cooke and Joseph A. Cushman.

Professional Paper No. 129F. The Foraminifera of the Mint Spring Calcareous Marl Member of the Marianna Limestone. By Joseph A. Cushman.

Water-Supply Paper No. 500C. Some Characteristics of Run-Off in the Rocky Mountain Region. By Robert Follansbee.

Forty-Second Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior, for the Fiscal Year ended June 30th, 1921.

Cobalt, Molybdenum, Nickel, Tantalum, Titanium, Tungsten, Radium, Uranium, and Vanadium in 1919. By Frank L. Hess.

Gold, Silver, Copper, Lead, and Zinc in Colorado in 1919. By Charles W. Henderson.

Natural-Gas Gasoline in 1919. By E. G. Sievers.

Barytes and Barium Products in 1920. By George W. Stose.

Cement in 1920. By Ernest F. Burchard.

Cobalt, Molybdenum, Nickel, Tantalum, Titanium, Tungsten, Radium, Uranium, and Vanadium in 1920. By Frank L. Hess.

Gems and Precious Stones in 1920. By B. H. Stoddard.

Gold, Silver, Copper, Lead, and Zinc in Idaho and Washington in 1920. By C. N. Gerry.

Gold, Silver, Copper, Lead, and Zinc in Montana in 1920. By C. N. Gerry.

Iron Ore, Pig Iron, and Steel in 1920. By Ernest F. Burchard and Hubert W. Davis.

Manganese and Manganiferous Ores in 1920. By H. A. C. Jenison.

Quicksilver in 1920. By F. L. Ransome. With a Supplementary Bibliography by Isabel P. Evans.

Salt, Bromine, and Calcium Chloride in 1920. By Ralph W. Stone.

Stone in 1920. By G. F. Loughlin and A. T. Coons.

Zinc in 1920. By C. E. Siebenthal and A. Stoll.

Cadmium in 1921. By C. E. Siebenthal and A. Stoll.

From the Department of Mines, Mines Branch, Canada :—

Memoir No. 127. Beauceville Map-Area, Quebec. By B. R. MacKay.

Memoir No. 128. Winnipegosis and Upper Whitemouth River Areas, Manitoba, Pleistocene and Recent Deposits. By W. A. Johnston.

From the Ministry of Finance, Egypt :—

Petroleum Research Bulletin C. Preliminary Report on the Chemistry of Egyptian Petroleum. By W. A. Guthrie, M.B.E., F.I.C., etc.

Note on the Programme and Policy of the Government with regard to the Investigation and Development of the Petroleum Resources of Egypt. By E. M. Dowson, C.B.E.

Petroleum Research Bulletin No. 10. Topography and Geology of Northern Sinai. Part I. By F. W. Moon, B.E., F.G.S., etc. and H. Sadek, B.Sc., F.G.S.

From the British Engineering Standards Association :—
Complete sets of Publications and Specifications.

From the British Science Guild :—
Catalogue of British Scientific and Technical Books, 1921.

From the American Gas Association :—
Gas Chemists Handbook.

From the Institution of Mechanical Engineers :—
Volume II. of the Transactions of the Institution, 1921.

From the American Institute of Mining and Metallurgical Engineers :—
Volume LXV. of the Transactions (Petroleum and Gas) of the Institute, 1921.

The attention of members is drawn to the new supplement of the Journal which deals with current Petroleum literature. To make this section of the maximum usefulness it is necessary that there should be full co-operation between chemists, engineers and geologists, and that matter which has inadvertently escaped notice shall be immediately sent to the Editor. The Institution is indebted to Mr. W. J. Wilson for the compilation of the bibliography.

Advertisements in the Journal. A limited number of Advertisements of firms interested in the Petroleum Industry may be inserted in the Journal. Application for terms, etc., should be made to Messrs. Commercial Publicity Service, 58, Warwick Street, Regent Street, London, W.1.

LIST OF ADVERTISERS.

(Members are desired, when making enquiries or placing orders with advertisers, to mention that they have seen their announcement in the Journal.)

ANGLO-AMERICAN OIL CO.
BRITISH PETROLEUM CO.
CARR BROS., LTD.
CHAPMAN & HALL, LTD.
A. F. CRAIG & CO.
W. CHRISTIE & GREY, LTD
DUNN MANUFACTURING CO.
W. J. FRASER & CO., LTD.
A. GALLENKAMP & CO.
HAYWARD-TYLER & CO.
HOLLAND DRILLING CO.
LUCEY MANUFACTURING CORPORATION.
NATIONAL SUPPLY CORPORATION.
OIL ENGINEERING & FINANCE.
OIL WELL SUPPLY CO.
VICKERS, LTD.
W. H. WILLCOX & CO., LTD.

PERSONAL NOTES OF MEMBERS AND SPECIAL NOTICES.

It is suggested that Members of the Institution send information regarding their movements to the Secretary for insertion under this heading.

Sir Thomas H. Holland has been appointed Rector of the Imperial College of Science and Technology in succession to Sir Alfred Keogh.

Lieut.-Colonel A. H. Burgoyne had the honour of Knighthood conferred upon him on the occasion of H.M. the King's Birthday.

Mr. F. E. Keep is now with Messrs. The Hyderabad (Deccan) Company.

Dr. George Sheppard, who has been engaged for the past three years in geological work in Western Canada, sailed from New York for Peru early in April.

Mr. John Towers left for Ecuador in June.

Mr. W. Calder has returned home from Trinidad.

Mr. James Clark Templeton is now with the Bitumen Company, Zagreb, Croatia, Yugo Slavia.

Mr. T. R. H. Garrett is in Burma. It was stated in the April issue of the Journal that Mr. Garrett had joined the staff of Colonel F. Johnson, Sons & Co., Rangoon. We beg to state that this is not the case, and his address is care of the Hong Kong and Shanghai Bank, Rangoon.

Mr. F. G. Rappoport has left for a business trip to Peru and will be absent for about four months.

Mr. E. E. Rigold has returned home from Egypt.

Mr. C. B. McKeever has returned to England.

Mr. J. M. Bailey is now in Havana.

PRICE OF JOURNALS.

As the stock of Numbers of the Journal become low, and owing to the cost of reprinting, the prices of these Numbers will be subject to increase without notice.

NOW READY.

PRICE, **14s. 6d.** TO MEMBERS, **10s. 6d.** (one copy only)
POSTAGE, **9d.** (INLAND.)

THE Council have pleasure in announcing that the new book

THE PETROLEUM INDUSTRY

A Brief Survey of the Technology of Petroleum based upon a Course of Lectures given by Members of the Institution of Petroleum Technologists on the occasion of the Petroleum Exhibition, Crystal Palace, 1920

is now published and can be obtained from the Secretary, the Institution of Petroleum Technologists, 5, John Street, Adelphi, W.C. 2.

CONTRIBUTORS:

SIR F. W. BLACK, K.C.B., B.A., M.Inst.P.T.
E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S., M.Inst.P.T.
G. HOWELL, F.G.S., F.R.G.S., M.Inst.P.T.
HUBERT MAY, M.I.Mech.E., M.Inst.M.M., M.Inst.P.T.
H. BARRINGER, M.Inst.C.E., M.I.Mech.E., M.I.N.A.,
F. B. THOLE, D.Sc., F.C.S., M.Inst.P.T. M.Inst.P.T.
W. R. ORMANDY, D.Sc., F.I.C., F.C.S., M.I.A.E., M.Inst.P.T.
PROF. J. S. S. BRAME, F.I.C., F.C.S., M.Inst.P.T.
JAS. KEWLEY, M.A., F.I.C., M.Inst.P.T.
ARTHUR W. EASTLAKE, M.I.Min.E., A.M.I.Mech.E.,
M.Inst.P.T.

Editor:
A. E. DUNSTAN, D.Sc., F.I.C., F.C.S., M.Inst.P.T.

ANNUAL REPORT OF THE COUNCIL, 1921.

The Membership of the Institution on December 31st, 1921, was as follows :—

Honorary Members	8
Members	276
Associate Members	125
Students	55
Associates	34
Total	498

This is an increase of 111 members as compared with the year ended December 31st, 1920, and in addition 14 candidates have been proposed for election.

For the period under review, the value of Journals sold was £256 6s. 1d. as compared with £212 12s. 11d. for 1920.

The receipts for advertisements are higher than last year. Arrangements have been made with an advertising firm, whereby it is anticipated that a considerable increase in revenue will be derived from this source, as the circulation of the Journal is now about 700 copies per issue.

The Institution has established an important Committee, under the Chairmanship of Mr. Alexander Duckham, for the purpose of dealing with the Standardization of the Nomenclature and the Testing of Petroleum and its Products. This Committee, known as the Standardization Committee, is a large one, and its members include representatives appointed by the Admiralty, the War Office, the Air Board, the Petroleum Department, the Government Laboratory, and the National Physical Laboratory. All possible assistance has been promised by many of the most important Companies interested in the Petroleum Industry, many of which are represented on the Committee by technical members of the staffs.

The Council have pleasure in stating that an entirely satisfactory financial position is indicated by the Balance Sheet attached. Due provision had to be made for the estimated expenses in connection with the Standardization Committee, as well as for the cost of printing the book entitled "The Petroleum Industry." The Council's policy of spending the revenue of the Institution liberally for the advancement of its objects has undergone no change.

During the year the Honorary Editor reports that five numbers of the Journal have been published containing the papers read at

the General Meetings, together with the discussions thereon, and also other contributions which were not read.

The papers published as set forth in the list below show the various subjects dealt with :—

At the Fifty-second General Meeting : "The Carbonization of Lubricating Oils in Internal Combustion Engines," by F. H. Garner, Mellon Institute of Industrial Research, University of Pittsburg, U.S.A.

At the Fifty-third General Meeting : "Working of Petroleum by Means of Shafts and Galleries," by Paul de Chambrier.

At the Fifty-fourth General Meeting : "The Crude Oils of Borneo," by J. Kewley.

At the Fifty-fifth General Meeting : "The Education and Training of a Driller," by A. W. Davson.

At the Fifty-sixth General Meeting : "The Mackenzie Oilfield of Northern Canada," by T. O. Bosworth.

At the Fifty-seventh General Meeting : "Trinidad as a Field for the Study of the Origin of Petroleum," by Professor P. Carmody.

At the Fifty-eighth General Meeting : "The Geology of the Egyptian Oilfields," by W. F. Hume.

At the Fifty-ninth General Meeting : "The Elimination of Oil Field Waste," by A. Beeby Thompson.

At the Sixtieth General Meeting : "Better Production Methods," by A. Frank Dabell.

The papers published but not read were :—

In Journal No. 28 : "The Relation Between Alcohol-Water Solubility and Spontaneous Ignition Temperatures," by W. R. Ormandy, and E. C. Craven.

"Some Notes on the Estimation of Sulphur and Chlorine by the Lamp Method," by S. Bowman.

Royal Aircraft Establishment Report, No. H.G. 410, "Report on Methods of Determining the Calorific Values of Certain Unsaturated Hydrocarbons."

Royal Aircraft Establishment Report, No. H. 861, "Report on the Calorific Values of Petrols and of Petrol Fractions."

In Journal No. 29 : "Notes on the Chemical Nature of Mineral Lubricating Oils," by A. E. Dunstan and F. B. Thole.

"The System Ethyl Alcohol-Water-Aromatic Hydrocarbons from 30° to —30° C.," by W. R. Ormandy and E. C. Craven.

The Institution is represented on :—

The Conjoint Board of Scientific Societies.

The British Engineering Standards Association.

The Imperial Mineral Resources Bureau.

The Fuel Economy Committee, British Association for the Advancement of Science.

The Committee of Birmingham University which is responsible for the education of Petroleum Technologists.

Owing to the resignations of Mr. G. Howell and Mrs. A. Lloyd Eastlake, as acting Secretary and Librarian respectively, Commander R E Stokes-Rees, R.N., was chosen from a very large number of applicants to occupy the dual position, as from September 1st, 1921, a selection which has been justified by the energy Commander Stokes-Rees has shown since taking up his duties.

Professor John Samuel Strafford Brame, F.I.C., F.C.S., has been unanimously re-elected President for the ensuing year.

Mr. Herbert Barringer, Sir George Beilby, The Rt. Hon. Viscount Cowdray of Cowdray, Mr. Arthur W. Eastlake and Sir Thomas H. Holland, Vice-Presidents, retire, and, being eligible, have been unanimously re-elected.

Mr. Alexander Duckham, Dr. W. R. Ormandy, Mr. T. C. Palmer, and Mr. Robert Redwood, Members of Council, retire, and, being eligible, have been unanimously re-elected.

It is with sorrow that the Council have to record the death of Mr. John S. Smith, one of their number. Mr. Smith occupied a prominent position in the Petroleum Industry, and his loss is keenly felt.

The Third Annual Dinner was held on March 17th, 1921, about 200 members and guests being present.

PROPOSED ALTERATION OF THE BY-LAWS.

That Article 3 of Section III. be amended by the Alteration of the figure 30, appearing in the fifth line, to the figure 28.

That Article 4 of Section III. be amended by the Alteration of the figure 25, appearing in the sixth line, to the figure 23.

That Article 5 of Section III. be amended in the following respect:—

By the addition of the words "nor more than twenty-three years of age" after word "age" appearing on the fourth line thereof.

That Article 4 of Section IV. be struck out and the following new Article inserted in lieu thereof.

4. "Every student shall, before reaching the age of twenty-three years, qualify himself to be an Associate Member, and shall obtain transference into that class in accordance with the preceding Article. In the event of any student not so qualifying himself, and not obtaining transference into the class of Associate Member, he shall be removed from the roll of members of the Institution. Provided, however, that the Council may in their discretion permit a student to remain

a student for such period beyond the time when he has reached the age of twenty-three years as they may think fit."

That Article 18 of Section IV. be amended by the Alteration of the words "Two" and "Three" in lines two and three respectively to the words "One" and "Six."

That Article 3 of Section VII. be struck out and the following Article be inserted in lieu thereof.

3. "The President shall be either a Member of the Council, a Vice-President, a past President, or past Vice-President. He shall be elected by the Members of the Council, and in the event of more than one name being proposed as President, the election shall be by the majority vote of the Council, such voting to be by Ballot. The Election of President shall take place prior to each Annual General Meeting, and the Office of President shall commence immediately after the conclusion of the Annual General Meeting. A President shall not hold office as such for a longer period than two consecutive years."

That Article 5 of Section VII. be struck out and the following Article inserted in lieu thereof.

5. "Every Member and Associate Member of the Institution may send in writing to the Council the name of a Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Members or Associate Members, and delivered to the Secretary not later than 31st day of January in any year. No Member or Associate Member may sign more than one Nomination Paper in any one year. At least thirty days before the date of the Annual General Meeting the Council shall prepare and issue to each Member and Associate Member, having a registered address in the United Kingdom, a list of Members for election to fill the vacancies caused by the retirement of Members of the Council, such lists to be regarded as the Balloting List. The Balloting List shall show the number of Members required to be elected, and shall state the date by which the Balloting Lists must be returned to the Secretary in order to reach him before the Ballot is closed. Each Member and Associate Member balloting is entitled to erase any name or names from the Balloting List, but any Ballot List shall be deemed invalid if the number of names remaining thereon shall exceed the number required to be elected. The Balloting Papers shall be returned sealed to the Secretary not later than the time at which the Ballot shall be declared closed, and shall be opened only on the day of the Annual General Meeting in the presence of the Council by a Committee

appointed for that purpose. The Candidates elected to fill the vacancies on the Council shall be those who received the highest number of votes, and every such person so elected, together with the President, Vice-President or Vice-Presidents elected by the Council and Members of Council who did not resign, shall form the Council for the ensuing year."

That Articles 2 and 3 of Section VIII. be struck out and the following new Articles inserted in lieu thereof.

2. "An Honorary Secretary of the Institution, who shall be a Member of the Institution, shall be appointed, on the recommendation of the Council, by the Members and Associate Members at the Annual General Meeting, as and when a vacancy occurs. Should a vacancy occur the Council may appoint a Member to fill the Office of Honorary Secretary until the next Annual General Meeting, when a nomination by the Council must be submitted to the vote of the Members and Associate Members present. The Honorary Secretary shall be *ex-officio* a Member of Council and responsible to the Council for the General Administration of the affairs of the Institution."
3. "The Council shall have the power to appoint a paid, whole-time Secretary, whose duty shall be to conduct the correspondence of the Institution, to convene and attend all Meetings of the Institution, of the Council, and of Committees to take Minutes of the Proceedings of such Meetings, to read the Minutes of the preceding Meeting and all communications that may be ordered to be read, to have charge of the premises of the Institution, and of the Library; to direct the collection of subscriptions and the preparation of the Accounts of the Expenditure of the Funds, and to present all accounts to the Council for inspection and approval. He shall also engage and be responsible for all persons employed under him, and shall generally conduct the ordinary business of the Institution in accordance with the Articles and By-laws and the directions of the President and Council, and shall confer with the Honorary Secretary on the conduct of the affairs of the Institution. The office of Secretary shall be determinable by three calendar months' notice, in writing, from any date to be given by the Council or the Secretary (as the case may be) to the other of them."

The Council desire to express their great appreciation of, and thanks for, valuable services rendered to the Institution by Sir William Plender, G.B.E., Honorary Treasurer, Messrs. Ashurst, Morris and Crisp, Honorary Solicitors, and Messrs. Price, Waterhouse and Co., Honorary Auditors.

The Council of the Royal Society of Arts have again afforded the Institution the privilege of holding its meetings at their House.

The Honorary Auditors, Messrs. Price, Waterhouse and Co., retire, and, being eligible, have kindly consented to agree to their re-appointment.

By order of the Council,

ARTHUR W. EASTLAKE,
Honorary Secretary.

REVENUE ACCOUNT for Year ended 31st December, 1921.

	£	s.	d.
To Salaries	554	1	
„ Rent, Rates, etc.	227	0	
„ Printing and Stationery	821	1	
„ Postage	53	8	
„ Hire of Hall for Meetings and Expenses of Meetings	125	11	
„ Sundry Expenses	120	5	
„ Balance carried to Balance Sheet	670	13	
	£2572	1	

	£	s.	d.	£	s.	d.
By Subscriptions :—						
Members	1145	0	6			
Special	1020	0	0			
				2165	0	
„ Interest and Dividends				87	16	
„ Sale of Journal				231	7	
„ Advertisements in Journal				87	18	
				£2572	1	

BALANCE SHEET, as at 31st December, 1921.

LIABILITIES.

	£	s.	d.	£	s.	d.	£	s.	d.
To Capital of the Institution, under Bye-law 14, viz. :—									
Life Membership Fund, per last Account				381	10	0			
Entrance Fees, per last Account	444	2	0						
Additions during year	153	6	0						
				597	8	0			
Donations as per last Account				250	0	0			
Donations received during year				50	0	0			
							1278	18	
„ Sundry Creditors							173	8	
„ Subscriptions paid in advance							154	15	

	£ s. d.	£ s. d.	£ s. d.	£ s. d.
To Revenue Account :—				
Balance 31st December, 1920		548 3 7		
Deduct—Subscriptions prior to 31st December, 1920, now written off ..	18 18 0			
Less—Arrears recovered	13 13 0			
		5 5 0		
		542 18 7		
Balance for the Year, as per Revenue Account		670 13 6		
				1213 12 1
				£2820 13 8

ASSETS.

	£ s. d.	£ s. d.	£ s. d.
By Investments, at Cost :—			
£664 6 6 London County 3% Consolidated Stock	481 10 6		
£600 0 0 War Loan 5% 1929-47	533 3 9		
£50 0 0 War Bonds 1927	50 0 0		
£150 0 0 Birmingham Corporation 6% Stock ..	146 16 0		
Note.—Market price of above Investments on 30/12/21 = £1128 19s. 6d.			1211 10 3
„ Office Furniture (excluding presentations) as per last Account			341 5 0
„ Library (excluding presentations) as per last Account	77 17 6		
Additions during year	12 5 6		
			90 3 0
„ Subscriptions (1921) outstanding at date and considered collectible			41 9 6
„ Sundry Debtors			143 19 9
„ Cash on Deposit			650 0 0
„ Cash at Bank and in hand			342 6 2
			£2820 13 8

J. S. S. BRAME,
F. W. BLACK. } *Members of Council.*

We have examined the above Balance Sheet with the Books of the Institution, and having obtained all the information and explanations we have required, we are of the opinion that such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Institution's affairs, according to the best of our information and the explanations given to us and as shown by the Books of the Institution.

3, Frederick's Place,
Old Jewry, E.C. 2.

1st February, 1922.

PRICE, WATERHOUSE & CO.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

Annual Dinner.

The Fourth Annual Dinner of the Institution of Petroleum Technologists was held at the Connaught Rooms on Tuesday, the 21st March, 1922, the President, Prof. J. S. S. Brame, occupying the Chair.

There was a very large and representative gathering, which included a number of distinguished guests, among whom were : Sir John Cadman, K.C.M.G. (President, Institution of Mining Engineers), Lieut.-General Sir T. E. Clarke, K.C.B., K.C.M.G. (Q.M.G. Army), Mr. E. V. Evans (Chairman, London Section, Society of Chemical Industry), Sir Philip Lloyd-Greame, K.B.E., M.P. (Minister in Charge, Petroleum Affairs), Mr. F. W. Harbord, C.B.E. (President, Institute of Mining and Metallurgy), Mr. W. St. D. Jenkins, C.B., C.B.E. (Director of Contracts, Admiralty), Mr. G. K. Menzies (Secretary, Royal Society of Arts), Mr. C. O. Milton (President, Deisel Engine Users' Association), Sir Joseph Petavel, K.B.E., F.R.S. (Director, National Physical Laboratory), Mr. F. E. Powell (Anglo-American Oil Co.), Sir Robert Robertson, K.B.E., F.R.S. (Government Chemist), Mr. W. C. Sneath (Hon. Auditor), Mr. Philip C. Tennant (Chairman, Petroleum Section, London Chamber of Commerce), Admiral Sir F. Tudor, K.C.B., K.C.M.G. (Admiral President, Royal Naval College), and Mr. George W. Watson (President, Institution of Automobile Engineers).

"The King."

The Toast of "The King" was proposed by the President, and was accorded musical honours.

"The Services."

Sir Thomas Holland, K.C.S.I., K.C.I.E., F.R.S., in proposing the Toast of "The Services," said : Mr. President and Gentlemen,—After the Toast of "The King" that of His Majesty's "Services" requires very little commendation. The Services carry on their work quietly, unostentatiously and efficiently. Governments come and Governments go—some of them do—but the Services go on for ever. (Cheers.) Like the poor, the Services are always with us—(laughter)—and, unless some discrimination is shown in the application of that instrument of execution that has been criticised so much recently, it is possible that the Services may even resemble the poor in some other and more uncomfortable respects. (Laughter.) Those who read and thoughtlessly believe

what they see in print must often wonder what an immense amount of ability and energy the Services devote to their work of carrying on the business of the Empire when they are handicapped in this way by having a Government over them. It is exactly fifty years since Lord Beaconsfield—then Benjamin Disraeli—said that "England does not love Coalitions." Well, I am not quite certain whether in making that statement he was correct, because in the Services we have a great Coalition—a Coalition that differs from some in being permanent—(laughter)—and differs from others in being permanently respected. (Laughter.) During the war the Government, in the presence of a common danger from without, found that it was desirable to reclassify some of their methods; they found it necessary to brush aside political expedients for the time being and to put in charge of their Departments as administrative heads a number of technical specialists. They thereby recognised that the technical aspects of the questions under stress superseded questions of general administration and even, for the time being, of politics. One result of that new classification of functions was that the Petroleum Department was formed, and the manifest success of that Department during the war was due in a large measure to the appointment of one of our past Presidents as its executive head. (Cheers.) I am not quite certain, with the number of changes that have occurred recently, whether my information is entirely up to date as to the exact form that the Petroleum Department now takes, but I am glad to know that we have the honour this evening of having with us, as one of our guests, the Minister responsible for that Department. (Cheers.) I hope he will take this opportunity of giving us an idea whether the Department has but a prospecting licence or is working under a mining lease. (Laughter.) At any rate, we all hope that a Department of that sort will not fall under the executive activities of the very much feared axe. (Laughter.) We realise that oil, which did its work as a military instrument during the war, is even more valuable now as an instrument of economic warfare.

I am perfectly sure that the members of every one of the other Services will agree with me if I select the Navy to respond to this Toast. I am sure everybody will agree that the Senior Service is the one on whose efficiency the action of all others for our security was based during the war. (Cheers.) As oil technologists we have a very intimate interest in the Navy, and the Navy has a very close connection with oil. It was the Navy which first realised (on an effective scale, at any rate) that oil was going to be of vital military value. I remember something like twenty years ago receiving in India enquiries from the Admiralty as to the possibility of the Indian Empire meeting the demand that might be made on it some day for liquid fuel. Later on, after

I had retired, Lord Fisher secured my services, in conjunction with the revered founder of this Institution, in connection with a Royal Commission for the purpose of organising a scheme which would enable the oil companies and the Navy to meet together for the purpose of satisfying the demand that was then possible and soon after became obviously probable. After the Commission had made its recommendations, and the Services had turned its recommendations to practical effect, the Navy was ready in 1914, first of all to hold in check, and afterwards to crush, an attack in which this Empire would have been but a mere item in the destruction of civilisation; as Lord Curzon picturesquely said, "Great Britain and her Allies floated to victory on a sea of oil." The genetic connection between oil, oil technologists, sailors and the Navy is so obvious that I apologise no longer for asking you to join with me in drinking to the health of the Services, coupled with the name of Admiral Sir Frederick Tudor.

The Toast was enthusiastically honoured.

Admiral Sir F. Tudor, K.C.B., K.C.M.G., who was received with cheers on rising to respond, said: Mr. President and Gentlemen,—I should like first of all to thank Sir Thomas Holland for his very eloquent and intriguing speech in proposing the Toast of "The Services," which I think would be more appropriately replied to by one of His Majesty's Ministers than by a naval officer such as myself. This is not the first time by any means that I have had to respond to the Toast of "The Navy," but this is the first time that I have ever had the honour of responding to the Toast of the three Services concentrated into one. There is no doubt about it that the fighting Services are being very much attenuated. I noticed in the paper the other day that the Financial Secretary to the Admiralty had stated that the Navy was being scraped to the bone. I cannot help noticing that according to the Estimates the combined fighting Services, or perhaps I should more strictly call them the combined Defensive Services, are going to cost you about 140 millions next year, in our depreciated currency. I also notice that you will have to find, roughly speaking, another 740 millions for all the other services of our country. I cannot help feeling that when the fighting Services upon which your very existence depends are being scraped to the bone there must be many succulent morsels that could be carved off the other services. However, I am more concerned to-night, Gentlemen, with developing the connection between the fighting Services and the petroleum technologist. In my career in the Royal Navy I have passed through three different phases of power as applied to locomotion. In my first seagoing ship I went round the world aided by wind power only. After that I spent three or four decades under coal, and I finished off my seagoing career under

the auspices of oil. As for the Army, what with its motor traction and its tanks, it is getting oilier and oilier every day. With regard to the Air Force, is not the spirit of petroleum the soul of the Air Force? Well, Gentlemen, I wish you all the best of luck in the progress of petroleum technology. Anything that you can do to advance the science will not only benefit civilisation generally, but must also redound to the advantage of the fighting Services. (Cheers.)

"The Petroleum Industry."

Sir Philip Lloyd-Greame, K.B.E., M.P., in proposing the Toast of "The Petroleum Industry," said: Mr. President and Gentlemen,—I rise not as you might suppose, and as I feel rather inclined, to respond to the charming speech of Sir Thomas Holland, in which he referred to His Majesty's Ministers with laudable courtesy, but to discharge the duty of proposing the Toast of the evening, "The Petroleum Industry." Gentlemen, that is the Toast of a very great industry. I suppose that no industry in the world has in the past decade made such progress and such advancement. In 1913 the production of oil in the world was something like 51,000,000 tons. Last year the production was nearly 110,000,000 tons. There is no industry in the world which can boast an expansion as complete as that; and as was natural the industry having started, both by natural circumstances and by applied science, in the United States of America, that great country is still responsible for two-thirds of the aggregate production of the world, and the British Empire, contrary to what many people would suppose, is responsible only for about 2 per cent. of that production. Now, great as has been the expansion of the industry, I make no doubt that far greater developments still await it in the future. New territories are waiting to be developed. All over the world there are fields of greater or less promise to which prospectors are increasingly drawn, and as the science of the industry develops increased uses will be found for its products. As research and development go forward, although it is probable that no very great proportion of the oil development of the world will take place actually in the territory of the British Empire, I have no doubt at all that the oil industry throughout the world will draw more and more for its brains, for its personnel, for its technical and scientific sides and for its administrative and commercial sides upon the brains of the young men of the rising generation of this country. I am bold enough to believe that you cannot find better brains anywhere than in the British Empire. It is the fashion nowadays to depreciate everything of our own, including our own currency. I do not share that feeling. I profess

a very profound belief in the natural qualities of the British people. I am sure of this, too—that in this development which will take place all over the world, not only will this industry be well advised to draw upon British brains, but in its development in far distant quarters of the world, in climates as varying as possible, the innate genius of the British race will show itself as eminently qualified to carry on the industry. If you want to develop an industry in a far country, if you want men who can manage men of one or another colour, if you want men who can meet one situation or another situation on the spot, no company, whatever its nationality may be, can do better than to draw upon the men who are being trained up in this country into the oil industry, so many of whom I see represented round these tables to-night. I know that not long ago it was a complaint that we could not find enough men of British training to go round. That question has been taken in hand. Distinguished professors are engaged in training men for this work, and I hope and believe that as these men come forward there will be full and ample opportunity for the great companies to absorb them in their work. I am certain that they will find no better talent and no better material to take into their operations. If the industry is to develop and to expand as I believe it will, two things are necessary, first that we should be sure that there will always be an ample and plentiful supply of the products of the industry, and second, that those shall be available to the shipping, commerce and the industry of the world at a reasonable and at a steady price. Those two very simple propositions are the key to British oil policy. There is nothing mysterious about it; there is nothing even new about it, and certainly there is nothing selfish about it. Those are two things which we feel in this country, and they represent a simple policy and desire which express not only the needs of this country, but the needs of the shipping, the industry and the commerce of every nation in the world which is going to use oil increasingly in the future. I have never been able to understand why there is so much mystery about oil. I think it is probably due to the fact that the average man knows so little about it. The average man believes that the oil industry is an interesting industry which is controlled by oil kings; that those oil kings are very wise—that, of course, is quite true; they are very rich—that, I hope, is true; and this, I am sure, is not true—there is a faint suspicion in the public mind that they are rather wicked. All those things are founded upon a great ignorance of the real position. There are many people who criticise the large profits which are made by oil companies. Those critics, I think, are apt to forget that whereas there are, in many cases, large profits, in many other cases there are very large losses. (Hear, hear); and in all cases, whether profit or loss accrues, there are very considerable risks

all the time in every venture. (Hear, hear.) You will never persuade the investing public in this world to go into an oil proposition, or an oil venture, on the basis of "the sweet simplicity of the three per cents." (Hear, hear.) That being so, if you engage in an adventurous industry, in an industry in which there are great risks, just as the risks are big so the prizes must be considerable. There is not only that misconception in the minds of the public about the real conditions of the oil industry, but this misconception intrudes in many other spheres. Oil ought to be an emolient. (Laughter.) As a matter of fact, it very often is anything but that. It is an unfortunate paradox, but none the less true, that in international affairs the effect of pouring oil upon troubled waters is not infrequently to create a conflagration, and that is due almost entirely to misconception and misunderstandings. I read from time to time the most amazing stories of what is the British oil policy, of what are the realities of the position, of what are the plans which untold people have in mind. They bear far less relation to the truth than what you read about politicians in the papers. (Laughter.) They read more like the scenarios from a cinema show than anything which bears a relation to the true facts. It is a most dangerous thing in any form of propaganda or of exposition to pass away from the simple facts of the case. I will tell you in two very simple sentences what is the object of British oil policy. It is simply that we want to see the greatest possible development of all the oil fields of the world because we know that will be to the good of this and other countries. I am perfectly certain that as these simple facts are known all these clouds of misunderstanding will be swept away and mutual understanding will breed common effort and common endeavour. I am delighted to find that, as an example of that, an arrangement has recently been made between a great British company and a great American company for joint work in one of the oil-producing regions of the world. That seems to me to be altogether to the good. It is good sense, it is good policy, and it is good business, and I hope that that kind of thing will go on. I had hoped that there would be here to-night to respond to this toast the president of the American company which has made that arrangement. We in this country shall not easily forget the work which Mr. Bedford performed for all the Allies in his conduct of the great Petroleum War Services Committee in the United States of America. (Cheers.) We are always glad to welcome him to this country. In the parlance in which business is described in the press, when it attains certain dimensions you always describe the persons conducting it as "The Big Five," or "The Big Four," or "The Big Three." One might perhaps not inappropriately describe Mr. Bedford as "The Big One" of the oil industry of the United States. I am sorry he is

not able to be present with us to-night, but we extend to him a very hearty welcome on his return to this country. I couple this toast with the name of another very distinguished man in the oil world, one who has proved, if proof were necessary, that when the business world really wants to get a good man it goes to the ranks of the Civil Service, more particularly one of the Civil Services which is closely allied with the fighting Services, in order to get those combined qualities of offence and defence which are necessary in a great commercial undertaking. (Cheers.) I give you the toast of the Petroleum Industry, and I couple it with the name of Sir Frederick Black. (cheers.)

The Toast was enthusiastically honoured.

Sir Frederick W. Black, K.C.B. (Past President), in responding, said: Mr. President, Sir Philip Lloyd-Greame and Gentlemen, I am very glad to have the honour of returning thanks for the industry, and particularly to thank Sir Philip Lloyd-Graeme for remembering that the strength of the industry depends not only upon what is done by the great oil companies whose names are known to all the world, not only by what is done by the directors in the board room, and others in the office, but upon the services of men such as those who are gathered here to-night who carry on the work of the industry in the rough places of the world, and under those difficult circumstances of climate and so on which Sir Philip has described to us. The geologist, the refiner, the engineer and the driller are all well known to us. I used to think it a great compliment to be told in the Admiralty that I tried to take the same view of things as my naval friends, and that my heart was with the sailor. I took it as a very great compliment, and I am sure he intended it as such, when Sir John Cadman at one of our meetings described how he went to a railway station to welcome me back from America, when someone said to him: "Which is Black?" He replied: "Why, that fellow over there, who looks like an old Oklahama oil driller." (Laughter.) Gentlemen, it very often happens at gatherings like these, when we have the honour and pleasure of the company of a Member of the Government, that he is asked to respond to the toast of the health of His Majesty's Ministers. I am sure that Sir Philip has been happier talking to us to-night about the oil industry than he would have been discussing the health of His Majesty's Government. (Laughter.) Those of us who know something of the anxieties of the oil world, and of those who are at the head of affairs in that particular industry, can spare a little sympathy for His Majesty's Ministers and those in charge of the Governments of most countries in the world at the present time. (Hear, hear.) Although I would not have you take a pessimistic view, I am sure that with all our difficulties we may look upon these troubles as altogether transient. We may gather

from the cheerful demeanour of Sir Philip Lloyd-Greame to-night that if the Geddes axe is going to touch in any degree the Overseas Trade Department or the Petroleum Department it is going to touch it very lightly, because we all of us in the oil industry and in the Institution of Petroleum Technologists feel that we owe much to our friends in the Petroleum Department. I think we can all say that our friend, Mr. J. C. Clarke of that Department, has the confidence of the whole industry. (Hear, hear.) When I was in America I used to meet oil men who had had business with him in London, and it would make him blush if I were to repeat what they said about him. We all regret the absence of Mr. Bedford—I, of course, more than anyone else—because it falls upon me to fill his place, very feebly, I am afraid. I believe it was here last year that I said something about my association with Mr. Bedford in America during the war, and a very close friendly co-operation it was. I know if Mr. Bedford were among us to-night he would take the broad and generous view that he always does take of everything connected with the oil industry. I had occasion once to listen to my friend, Mr. Powell, speaking the praises of Mr. Bedford and the work he did during the war. I said then that I could add one word which, I believe, has the same significance on the other side of the Atlantic as it has upon this, namely, that I should describe Mr. Bedford's attitude as, in the best sense of the word, "statesmanlike." It is very satisfactory to many of us here to know that the Minister in charge of petroleum affairs in this country does not share the fears that some people have of oil companies usefully co-operating. I venture to believe that he thinks, as many of us think, that some measure of co-operation of that kind is going to do good, even to that person who is not always supposed to be remembered, I mean the oil consumer. Sir Philip has given us some figures of the production of crude oil in the world for the year 1913, and he showed that by the year 1921 the production had practically doubled. If you go back over something like thirty years from 1900, you will find that in every ten years the oil production of the world has just about doubled itself. If you take the year 1921 and compare it with 1920 the percentage of increase would lead one to believe that we are going to have something like twice that quantity annually ten years hence. It may be so, but I suggest that the oil world would be very well content if it gets 50 per cent. or 60 per cent. increase in the next ten years instead of double. Mind you, I will not prophesy that it will not double itself, but I suggest that there was an exceptional and abnormal stimulation of the supply of oil during the years of the war and the period that immediately followed. I suggest to you also that during the next ten years we are going to see a very great adjustment as between the producer of oil and the maker of engines or apparatus for

which oil is used. I hope we are going to see the Navy use oil in a more economical fashion than it does at present. At the conference held at Chicago, to which I have previously referred, it was pointed out that the two great uses of oil in the future are going to be oil for internal-combustion engines and the heavy type of oil that is used for Diesel engines and lubricating oil. The oil chemist is very often called upon to perform miracles in what he does in the manipulation of his product, and he retorts by asking the engineer to perform miracles in his mechanisms. Both of them properly remind us of the natural limitations imposed on their products or manufactures from an economic and physical point of view. We are going to see in this period of ten years or thereabouts a very great difference in the refining of oil and the use to which the products will be put, and a little "gentle friction" between the producer and the engineer is going to be good for my friend the consumer. I think that is going to be one of the main features of the period that lies immediately in front of us. It is something to which the Institution of Petroleum Technologists will certainly contribute. I am sure it has been a great delight to all of us to have the responsible Petroleum Minister with us to-night. We are greatly indebted to him for the broad and enlightened view he has taken. I know that one of my friends in the petroleum world says that half of the faults that are made by our political governors are due to the fact that they have not had a proper training in petroleum technology, and we are prepared at any time to put that right. (Laughter.) We have made a very good beginning with the present Minister in charge of petroleum affairs. We can see his influence and the influence of his expert advisers in those despatches that are sent out on the international aspects of the oil question, and as the association between that Department and the petroleum technologists grows closer we shall see that influence still more brought to bear—an influence always impartial, always judicial, always growing more and more expert. I thank Sir Philip on behalf of the oil industry for the kind terms in which he has referred to us. (Cheers.)

Sir Robert Robertson, K.B.E., F.R.S., in proposing the Toast of "The Institution of Petroleum Technologists," said: Mr. President and Gentlemen, I should like in the first place to congratulate you on the prosperity of your Institution. I understand that your membership in the last two and a-half years has increased two and a-half times, and that that should be so appears to me to be natural in a country which has such important interests in oil. The activities of your Institution are exemplified in co-ordinating the work of divers men of science. You co-ordinate the work of the engineer, the geologist and of the chemist, and it is among your objects to produce a technologist in petroleum of high pro-

fessional standing. Among the activities that you engage I propose to consider those of education, the holding of meetings, and the work of your Committees. We have heard to-night from the Minister the importance that he attaches to the education of the student in petroleum technology, and it is well to learn, therefore, that the number of your students has increased by three times in the last two years. I gather from the association your students have with the Institution generally that it is your policy to encourage them by offering them facilities connected with your library and your publications. No doubt, in an Institution such as this, containing so many experts in the subject with which you deal, the same care will eventually be exercised over the education of your students as a similar Institution, the Institute of Chemistry, exercises over its students. As regards your meetings, it is obvious to anyone who reads your Journal that many and important papers are read and discussed there. While we are, of course, an individualistic people, and while, before the price of paper and printing made it difficult, we were too prone to set up a new journal on the slightest hesitation, I think there is a good reason for the publication of your Journal. It might be argued that much of the subject-matter belongs to the domain of chemistry and appropriately forms part of the proceedings of, say, the Society of Chemical Industry, but when one considers the diverse interests that you have to satisfy, in engineering, in geology, as well as in chemistry, there is good reason for the existence of such a Journal as yours. To ensure that matters of interest in other chemical journals do not pass unnoticed, and that chemical papers published in your Journal are brought to the notice of chemists generally, I am glad to hear that a mutual system of abstracting has been devised. As regards your Committees, I think no one would deny the need for that which deals with nomenclature. For instance, to take one of the products with which you deal—petroleum ether—it may safely be said that the chemist does not recognise it as an ether at all, and motor spirit is an equally misleading appellation. There is no doubt of the need for attention to be paid to nomenclature. With regard to your other important Committee on standardisation, it is the case that when technique reaches a certain stage in its development the demand arises for definitions, and it is of interest to note in this connexion that you are co-operating with the corresponding American Society which already has gone to a considerable length in standardisation. Founding upon this very short account of your activities I put before you the Toast of the Institution, which I would like to associate with the name of your President. I have known Prof. Brame now for many years, and that makes it difficult for me to praise him to his face. You know, however, of his many merits, and that the mantle of his illustrious predecessor

has worthily fallen upon him. It affords me, therefore, much pleasure to propose the Toast and to couple it with the name of the President, Prof. Brame. (Cheers.)

The Toast was enthusiastically honoured.

The President : Sir Robert Robertson and Gentlemen, Sir Frederick Black reminded us at a previous dinner of a saying of King David that "Oil giveth to man a cheerful countenance." Looking round to-night on your cheerful countenances and your general happy demeanour I think that oil must be really a miraculous fluid. I feel, however, that if your cheerful countenances are entirely due to oil that your cruse has had some measure of spirits in it. (Laughter.) It has always been a remarkable fact to my mind that this Institution of Petroleum Technologists should have been founded in a country which is practically a non-producer of oil. Its foundation was due to our illustrious first President, Sir Boverton Redwood, whose great appreciation of the necessity of some Institution which would develop the technology of oil, which would encourage the scientific investigation of problems relating to oil, was so very keen that he realised that, handicapped as we were in this country in the matter of production, yet because of the great British interests in oil it was highly desirable that we should start an Institution in this country which would develop the technical and the scientific side of that great question. Young as this Institution is I think it can reasonably be claimed that it has done no inconsiderable amount to advance the technology of oil. We have, as a young Institution, had to struggle with somewhat adverse circumstances. We started in the early part of 1914, and a very few months after the initiation of this great Institution the outbreak of war occurred. That, of course, put a stop to any rapid development, but still we carried on. Our early activities were rather restricted to what I may call educational development, such as one gets from the reading and discussion of technical papers and their publication in our Journal, together with the benefits derived from the library. But that slow progress has passed, and since the Armistice the Institution has gone ahead, until we have at the present time a membership in all classes of over 500 members, which was the high-water mark, as it were, that was laid down in the first Articles of Association which were approved by the Board of Trade for this Institution. We have now devoted our attention to other matters. Previously it had been rather in the direction of the higher education of technologists, but to-day we are paying more attention—and I hope in the future we shall pay still more attention—to the education of those who have not reached quite the same heights as those oil technologists who are able to go into all parts of the world and control the production and refining of oil, or act as advisers to the great companies which are producing oil.

We have now in this country—and I am happy to say this Institution has been closely associated with some of the developments—two great Institutions where oil technology is being taught, the Imperial College of Science and Technology at South Kensington, and Birmingham University, the latter a course the early development of which owed so much to one of my predecessors in the office of President, Sir John Cadman. (Cheers.) There is also in London a development which, although not officially connected with this Institution, nevertheless is happily blessed by the advice of many of our Members of Council, including Sir John Cadman and Sir Frederick Black, the course in oil technology which is being conducted at the Sir John Cass Technical Institute. There we are endeavouring to improve the general education in technical matters of the members of the staffs of the great oil companies. We feel that it is to the advantage of these companies that their technical staff, whether they are actively engaged in the production of oil or the refining of oil, should have a broad knowledge of fundamental points in connexion with oil. From that we shall succeed in training up a specialist body of men who will be of great service to the oil community, and we may in time be able to select from the students men who will be able to go out and take their place in the various producing centres of oil under those companies.

Then there is the other point which Sir Robert Robertson has mentioned, the question of standardisation. As you know, we have recently established a Standardisation Committee, which will deal not only with the standardisation of methods of testing, but with nomenclature, to which Sir Robert Robertson has also referred. I would like to express the appreciation of the Council of the Institution for the great assistance which is being given to us by the hearty collaboration of such Departments as the Government Chemists Department, over which Sir Robert Robertson presides, and of the National Physical Laboratory, the Director of which, Sir Joseph Petavel, is present with us this evening.

There is one other phase of our development which has not been mentioned to-night, and that is that we are launching out as publishers. It will be within the recollection of the Members of the Institution that in the autumn of 1920 some of the Members of the Council and other Members of the Institution collaborated in giving a series of lectures at the Crystal Palace in connexion with the great exhibition that was held there. Your Council decided that it would be an excellent thing if those lectures were reprinted and issued as a popular treatise—not a popular treatise in the ordinary newspaper sense, but a treatise which, shall we say, the man in the street who owned oil shares could read and would appreciate. I am happy to say that we have that book containing

those lectures and some extensions of them practically ready for issue to the public.

Passing away from these particular topics for a moment, I should like to refer to a point which has been mentioned by Sir Frederick Black and other speakers, and that is the regret of the Institution that Mr. Bedford and some of his associates of the Standard Oil Company were not able to be present with us to-night. We felt that we were happily situated that the night of our Annual Dinner should happen to synchronise with the visit of Mr. Bedford and his colleagues. We had every hope that they would be present to-night. I think we might have promised them that they would not have gone dry, unless it had been from a question of choice. We are disappointed, however, but I would like to say that I feel—and I think the Council of the Institution feels—that desirable as it may be to have some understanding with our American confreres on the matter of the commercial side of the production of oil, it is perhaps equally important that we should have an understanding with and work in collaboration with our scientific and technical confreres in the great American oil industry. It is one of those things that I hope before long we shall see accomplished—that we shall go hand in hand in the development of the technology of oil and in the investigation of the various scientific questions which still remain to be solved. It may be desirable in business affairs that we should have competition. In scientific affairs it is desirable that we should have collaboration and not competition. We all appreciate the very great work which has been accomplished in America during the last few years on standardisation, and our Committee has received most cordial promises from our American colleagues of help in every possible way. I have only one suggestion to put forward. This Institution is the Institution of Petroleum Technologists. It is not the English Institution; it is not the British Institution of Petroleum Technologists. I rather lay emphasis on the Institution, and I sincerely hope that we shall be able to arrive at such a stage of understanding with our American friends that we shall have the Institution of Petroleum Technologists representative of the whole of the British-speaking peoples. I feel that we can well work in this direction; that it may be possible to arrange with American technologists that they shall publish their papers in a journal which will be the Journal of the Institution of Petroleum Technologists, and that we shall have the advantage of those papers in our Journal, in fact there will be one Journal, probably published on both sides of the Atlantic simultaneously. If we can reach such a stage as that; if we can collaborate together in every way, we shall be able to achieve results which will be of the utmost importance to the industry.

Sir Robert Robertson and Gentlemen, I thank you for the very

cordial way in which you have received the toast of "The Institution of Petroleum Technologists." The sturdy young infant of eight years of age is progressing favourably. His guardians will very soon have to take him out of knickerbockers and put him into long trousers, because we see in every way the development which we hoped for years ago. We have recently appointed a Controller of this robust infant in the person of our energetic Secretary, Commander Stokes-Rees, and we have always had as the godfather of the sturdy infant, Mr. Arthur W. Eastlake, our Honorary Secretary. (Cheers), and when his benevolent uncles, the Members of our Council, are disposed to spoil the infant, we always have this benevolent godfather holding us in check and reminding us of the vows which were taken at the baptism of the infant some eight years ago. (Cheers.)

"THE GUESTS."

Dr. Ormandy, in proposing the toast of "The Guests," said: I have been called upon at very short notice to propose the toast of "The Guests" who are present with us to-night. At this late hour I do not propose to take up very much of your time, but I would like to refer to the presence of a few gentlemen who represent the industries so closely associated with ourselves, and who are thus indirectly connected with the oil industry. We have present Mr. Watson, who is the President of the Institution of Automobile Engineers. It is not a well-known fact, but it is a fact, that about 26 per cent. of the total volume of oil produced in America is consumed by the automobile industry. What percentage of the lubricating oil is used by the automobile industry I should not like to say, but I do know that most of the makers of motor cars state that they can go a thousand miles on a gallon of oil. If they did I think the oil industry would feel a draught. There is every evidence, in spite of the fact that there is at the present moment somewhat of a surplus of oil, that the insatiable demand of the motor industry will be for more and more fuel, possibly for more than the oil industry will find it easy to produce, and it is to the efforts of the Institution of Automobile Engineers and engineers in the motor industry generally that we have to look for those economies, which they can bring about with a view to producing more power at a cost of less fuel. I do not think there is the co-operation that might have existed between the Institution of Automobile Engineers and ourselves, and I welcome the presence of the President of the Institution in the hope he will carry to his Council the desire of this Institution that there may be closer co-operation between the two Institutions, as we frequently have papers which are of vital interest to the motor industry, and they have papers which are of the greatest interest to us. It does seem a

waste that there should not be closer co-operation and joint papers read in the manner that is being carried out by the Society of Chemical Industry in conjunction with the Institution of Mechanical Engineers.

We have also present to-night Mr. Milton, the President of the Diesel Engine Users' Association. They are a body representing practically the whole of the Diesel Engine and semi-Diesel Engine users in this country. They hold meetings at which the most interesting technical points are raised, but they are raised entirely for the benefit of the user. I am confident that if there were closer co-operation between our Institution and theirs it would be for the benefit, not only of the members of our Institution, but of theirs as well. It is not only our duty to know all that is possible about oil as oil, but we ought at the same time to be willing to know what are the difficulties and troubles that the users of oil meet with. I hope that the future will bring about a closer working arrangement between the two Institutions than has existed in the past. I was a little astonished to find that one of our most active members and a past President was present as a guest—Sir John Cadman, who, I gather, is present as the President of the Institution of Mining Engineers. I think we may be allowed to congratulate Sir John on his translation from a position of importance in the Government to a position of equal eminence in a non-Government capacity. A very prominent member of the Government has recently stated that these high authorities in Government Departments are, as it were, like people upon the top of a high hill, who are subject to the buffeting of the elements, and that they are frequently in a mist. If a mist is synonymous with a fog I think we shall agree that these great politicians are frequently in a fog (Laughter), and I have no doubt that Sir John Cadman will feel that he is in a position where he can regard the swinging of the Geddes axe with a much greater degree of equanimity than might have been the case if he had been a Government servant. We welcome him as a guest, though we regard him as one of ourselves. We regret the absence of Brig.-General Bagnall-Wild who represents the Air Force. I never know what his position actually is. (Laughter.) It varies so rapidly from day to day that one has to ring his secretary up on the telephone to know exactly how to address a letter to him. (Laughter.) At any rate, we do know that he represents the Air Department of the Government, which is the Department that consumes a vast amount of our best grade of petrol, and, so to speak, takes all the cream from the petrol, so that we, the ordinary motorists, have to use what is left. We welcome also Mr. Powell. I think all of us will remember with great delight the marvellous speech with which he interested and amused us on the occasion of the last dinner. The toast is associated with the name of Mr. Harbord,

who is the President of the Institution of Mining and Metallurgy. We welcome him because the industry which he represents is realising more and more the advantages that are to be derived from this protean substance, oil. Time is so short that I will not detain you any longer, and I will therefore ask you to join with me in drinking to the health of the guests who have honoured us by being present to-night, and I couple the toast with the name of Mr. Harbord. (Cheers.)

The toast was duly honoured.

Mr. F. Harbord, C.B.E. (President of the Institution of Mining and Metallurgy), in responding, said : Mr. President and Gentlemen, In replying to this toast I have to thank Dr. Ormandy on behalf of my fellow guests and myself, for the very kind way in which he proposed this toast and the enthusiastic way in which you have received it. In looking round at the distinguished guests who are intimately acquainted with your industry I feel that the reply to this toast should have been placed in other hands, and it is only the unavoidable absence of Brig.-General Bagnall Wild which has prevented him from responding to this toast. We have heard from your President of the remarkable progress which has been made by your Institution during its infancy. As a rule the period of youth is confined to contriving all manner of wickedness, and it is reserved for the period of manhood to carry out the wickedness contrived in its youth, but your Institution has taken itself so seriously that it is already doing most important work, on which I heartily congratulate it. We were taught when we were young that "Brevity is the soul of wit," and to-night I do not know whether you would appreciate my wit if I had any, but at this late hour I am quite sure you will appreciate my brevity. I therefore thank you once again on behalf of my fellow guests and myself for your hospitality to-night and for the cordial way in which you have received this toast. (Cheers.)

During the course of the evening an excellent programme of music was rendered by the British Imperial Orchestra, under the direction of Mr. Arthur Crudge, and songs were sung by Miss Doris Smerdon and Mr. Tom Howell.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Ninth Annual General Meeting of the Institution was held at the House of the Royal Society of Arts, John Street, Adelphi, London, on Tuesday, the 14th of March, 1922, at 5.30 p.m. Professor J. S. S. Brame, President, in the Chair.

The Minutes of the Eighth Annual General Meeting, held on the 22nd March, 1921, were read and confirmed.

The Secretary read the notice convening the meeting.

The President laid on the table for inspection the List of Members, Associate Members, Students and Associates who had been elected to the Institution since the date of the last Annual General Meeting.

The President—in moving the adoption of the Annual Report, which was taken as read—spoke shortly on some of the work of the Institution referred to in the Report. He said that when he was honoured by being elected as President he expressed the view that the Annual General Meeting should be a live meeting—one at which the well-being of the Institution could be discussed and suggestions made which might forward its interests. He was glad to see that evening what he thought was a record attendance at the Annual General Meeting of the Institution. He expressed his very high appreciation of the honour which the Council had done him in again electing him as President for the ensuing year. When he accepted the office in the first place he certainly did not realise quite the large demands which would be made on the time of the President. He was not perhaps such a busy man as some of his predecessors, and he thought that the Institution was tremendously indebted to those predecessors, who had been busy active men, mostly engaged in affairs in the City, in that they had been able to spare the time necessary for so ably conducting the affairs of the Institution. The last year had been one of very considerable activity, because the Council had had to devote a great deal of time to the consideration of the recommendations of the Special Sub-Committee appointed to consider the working of the Institution; the result of those deliberations was in the Report, which contained certain proposals to alter the By-Laws.

The Council and the Publication Committee had also devoted a good deal of time to the production of the book, *The Petroleum Industry*, which he was glad to say would be issued within the next four weeks. That book would be unique in its way in connection with the industry. The Council had taken the responsibility of

producing the book and of being its own publisher; and they looked to the general body of members to support them and to make the book known, because the Council were committed to fairly heavy financial responsibility, and did not want the Institution to suffer in any way through its enterprise in bringing out the book, which he thought would be of great service, not only to members, but to all people interested in Petroleum Oil. Referring to the Journal, the Council desired to give members, as far as possible, a publication which would be of the greatest value to them, especially to the large number of members who were abroad, or unable to attend the meetings, for the Journal was the main return they obtained. New features had been introduced, such as original scientific papers which were not read before the Institution, the publication of abstracts, and the publication of a bibliography in the Journal—and he thought these features had materially improved it. He wished to express the indebtedness of the Institution to the Hon. Editor, Dr. Dunstan, and to those who had assisted him in the matter of the production of the abstracts and a suitable bibliography. Dr. Dunstan had put in a very great deal of time in connection with the Journal and the forthcoming book.

Lastly, he referred to the fact that a Standardisation Committee had been set up, which he thought was of the greatest importance, and he looked forward to the Committee producing results of the greatest value to the industry and to the Institution.

Mr. Howell seconded the motion, and there being no questions asked, the Report was unanimously adopted.

Dr. Leo Henderson asked whether the adoption of the Report meant the adoption of the recommendations in the Report.

The President said he had specially excluded that and had moved definitely the adoption of the Report other than the section referring to the proposed alteration of the By-Laws.

BALANCE SHEET.

The Secretary presented the balance sheet and read the Auditor's Certificate.

Mr. Adams (Chairman of the Finance Committee) said the Balance Sheet and Accounts were fairly self-explanatory, but it might interest the members if he made a few comparisons. Taking the Revenue Account on the expenditure side and comparing it with the year ending 31st December, 1920, it would be found that the expenses were very much the same. The subscriptions on the other side of the Revenue Account for the year 1921 had increased by a little over £300; the amount received from Interest and Dividends was slightly more—about £25—and the sale of the

Journal had increased to an amount of about £50. The result was that the balance at the credit of the Revenue Account for 1921 was £670, as against £495 in the preceding year.

Sir John Cadman moved the adoption of the Accounts.

Mr. Adams seconded the motion.

Dr. Henderson said the Balance Sheet was a very creditable document for such a young Institution, but there was one point which caused him some uneasiness. The publication of a book was more or less of a gamble in these days of high cost of printing and publication, but it might be abundantly justified in the present case. Such a publication would, no doubt, be most welcome and be looked forward to with great interest by every member and possibly by the general public. He did not wish to move any amendment, as he gave the balance sheet his approval.

Mr. Hackford said that the Institution should be second to none in the position it took in the oil world, and they should maintain a high standard of efficiency, and he strongly approved of the formation of the Standardisation Committee.

The President, replying to a question from Mr. A. E. Evans, as to how many copies of the book were being published, said the number would be 1500.

The Motion for the adoption of the Balance Sheet was carried unanimously.

AMENDMENT OF BY-LAWS.

The President said the proposed alteration of the By-Laws had been, to a large extent, with a view to meeting suggestions which were put forward to the Council by the small Committee, consisting of four members of the Council and four members elected from the general body of members some one year ago; and the Council as a result, after considering all the submissions made, had drafted the alterations which appeared in the Report. The members were entitled to make the alterations in the By-Laws by virtue of Article 23 of the Articles of Association.

The first alteration was: "That article 3 of section III. be amended by the alteration of the figure 30, appearing in the fifth line, to the figure 28."

Dr. Henderson asked for some expression from the Council as to the reason why they proposed to reduce the age of membership from 30 to 28. It had always appeared to him that the age of 30 was early enough for full membership of a scientific institution. However brilliant a student might be, study of books could not

replace practical experience, and in the majority of cases sufficient practical experience was not obtainable under 30 years of age to qualify for full membership of an Institution of such high standing as the Institution of Petroleum Technologists. He proposed as an amendment that the figure 30 should remain.

Dr. Ormandy said that, as Chairman of the Committee he should like to inform the last speaker that it was the unanimous opinion of the members of the Committee who represented the Body of Members and Associate Members, that the age should be reduced. There was no doubt that, as a general rule, it was perhaps advisable, but it must be remembered that it was also within the discretion of the Council. There were certain cases where men had got through their degrees at an early age and were particularly brilliant or had an unusually wide experience, and it was hard that such men should be prevented from becoming members merely because their age (and not their qualifications or experience or knowledge) prevented their becoming members.

Mr. Pitt said that he would formally second the amendment, otherwise it would be impossible to take a vote in the matter, and it was advisable to have an expression of opinion upon the point.

The amendment was put to the meeting and lost, and the alteration in the By-Law was carried.

The President then proposed that: "Article 4 of Section III. be amended by the alteration of the figure 25, appearing in the sixth line, to the figure 23."

Dr. Henderson said that he had the same objection to that. He did not understand how it was that a large number of members could ask the Council to lower the limit, because experience, so far as he had been able to gather in different parts of the world, clearly indicated the paramount necessity for experience before obtaining full membership of an important Institution. Experience seemed to count more and more in such matters; without practical experience it was almost impossible to weigh fully the pros and cons of the various questions which came up for decision. On those grounds he protested against the alteration but did not think that he need move an amendment because, obviously, the feeling was against him; but he hoped that in future the By-Law would be amended and that the age limit would be raised again.

The President said the Council did not want to alter the By-Laws more frequently than was necessary, and it might be well for Dr. Henderson to put his amendment definitely, so that the question could be decided and the Council have something definite to go upon.

Dr. Henderson said in that case he would move his amendment that the alteration be not made.

There being no seconder of the amendment, it fell to the ground and the alteration was adopted with one dissentient.

The President said there was some latitude allowed to the Council; the question of discretion came in and they had particularly under consideration the ex-Service men. Further on in the By-Laws it would be found that it was left to the Council to a large extent to decide in exceptional cases—so that he did not think any very serious alteration was being made.

The President then moved that: "Article 5 of Section III. be amended in the following respect:—

> "By the addition of the words, 'nor more than twenty-three years of age,' after word 'age' appearing on the fourth line thereof."

The alteration was carried.

On the proposition of the **President**, the following alteration was also agreed to: "That Article 4 of Section IV. be struck out and the following new article inserted in lieu thereof:—

> "Every student shall, before reaching the age of twenty-three years, qualify himself to be an Associate Member, and shall obtain transference into that class in accordance with the preceding article. In the event of any student not so qualifying himself, and not obtaining transference into the class of Associate Member, he shall be removed from the roll of members of the Institution. Provided, however, that the Council may, in their discretion, permit a student to remain a student for such period beyond the time when he has reached the age of twenty-three years as they may think fit."

Also on the proposition of the **President**, the following alteration was agreed to:—

> "That Article 18 of Section IV. be amended by the alteration of the words 'two' and 'three' in lines two and three respectively, to the words 'One' and 'Six.'"

The President then moved: "That Article 3 of Section VII. be struck out and the following Article be inserted in lieu thereof:—

> "The President shall be either a Member of the Council, a Vice-President, a Past President or past Vice-President. He shall be elected by the members of the Council, and in the event of more than one name being proposed as President, the election shall be by the majority vote of the Council, such voting to be by Ballot. The election of President shall take

place prior to each Annual General Meeting, and the office of President shall commence immediately after the conclusion of the Annual General Meeting. A President shall not hold office as such for a longer period than two consecutive years."

The alteration was adopted.

The President then proposed: "That Article 5 of Section VII. be struck out and the following article inserted in lieu thereof:—

"Every Member and Associate Member of the Institution may send in writing to the Council the name of a Member whom he desires to recommend for election to the Council. This nomination must be signed by at least nine other Members or Associate Members, and delivered to the Secretary not later than the 31st day of January in any year. No Member or Associate Member may sign more than one Nomination Paper in any one year. At least thirty days before the date of the Annual General Meeting the Council shall prepare and issue to each Member and Associate Member, having a registered address in the United Kingdom, a list of Members for re-election to fill the vacancies caused by the retirement of Members of the Council, such lists to be regarded as the Balloting List. The Balloting List shall show the number of Members required to be elected and shall state the date by which the Balloting Lists must be returned to the Secretary in order to reach him before the ballot is closed. Each Member and Associate Member balloting is entitled to erase any name or names from the Balloting List, but any Ballot List shall be deemed invalid if the number of names remaining thereon shall exceed the number required to be elected. The Balloting papers shall be returned sealed to the Secretary, not later than the time at which the ballot shall be declared closed, and shall be opened only on the day of the Annual General Meeting, in the presence of the Council by a Committee appointed for that purpose. The Candidates elected to fill the vacancies on the Council shall be those who received the highest number of votes and every such person so elected, together with the President, Vice-President or Vice-Presidents elected by the Council and members of Council who did not resign shall form the Council for the ensuing year."

A Member suggested that the words, "A list of members for re-election" should read, "A list of members for election."

It was duly proposed by **Mr. Howell**, and seconded by **Sir Frederick Black**, that the "re" should be deleted and the motion was carried.

Mr. MacDougall said, as he understood the proposed amend-

ment, it would be necessary for nine members to support the nomination and that would be rather running a risk of missing talented and useful men to serve on the Council. He therefore suggested that instead of nine it should be three.

Mr. Howell said a member elected on the Council was supposed to be representative of the various members of the Institution, and unless such person could get at least 2 per cent. of the members of the Institution he was not representative of the members, who were supposed to place him in a very responsible position. Therefore he opposed the amendment.

The President pointed out that the Council had very carefully considered the point; it was necessary to bear in mind that the Ballot List might be overwhelmed by nominations by small groups, and that was one reason why the larger number than four or five had been selected.

There being no seconder, the amendment fell to the ground and the original proposal was carried.

The President then moved: "That Articles 2 and 3 of Section VIII. be struck out, and the following new Articles inserted in lieu thereof:—

"2. An Honorary Secretary of the Institution, who shall be a Member of the Institution, shall be appointed, on the recommendation of the Council, by the Members and Associate Members at the Annual General Meeting, as and when a vacancy occurs. Should a vacancy occur, the Council may appoint a Member to fill the office of Honorary Secretary until the next Annual General Meeting, when a nomination by the Council must be submitted to the vote of the Members and Associate Members present. The Honorary Secretary shall be ex-officio a Member of Council and responsible to the Council for the General Administration of the affairs of the Institution."

"3. The Council shall have the power to appoint a paid whole-time Secretary, whose duty shall be to conduct the correspondence of the Institution, to convene and attend all meetings of the Institution, of the Council and of Committees, to take Minutes of the proceedings of such meetings, to read the Minutes of the preceding meeting and all communications that may be ordered to be read; to have charge of the premises of the Institution and of the Library; to direct the collection of subscriptions and the preparation of the accounts of the expenditure of the funds, and to present all accounts to the Council for inspection and approval. He shall also engage and be responsible for all persons employed under him and shall generally conduct the ordinary business of the Institution

in accordance with the articles and by-laws and the directions of the President and Council, and shall confer with the Honorary Secretary on the conduct of the affairs of the Institution. The office of Secretary shall be determinable by three calendar months' notice in writing from any date to be given by the Council or the Secretary (as the case may be) to the other of them."

The alterations were unanimously adopted.

In connection with every alteration, the **Secretary** read the old By-Law and the proposed alteration.

RE-ELECTION OF HON. AUDITORS.

Mr. Ockenden proposed the re-election of the Hon. Auditors, Messrs. Price, Waterhouse and Co., for the ensuing year.

Mr. May seconded the motion, which was carried unanimously.

Dr. Henderson said there was some doubt as to the effect of Article 2 on the Hon. Secretary. According to the reading of the article, the Hon. Secretary had to be re-elected at the present meeting.

The President said the article would become operative next year, and therefore the re-election of the Hon. Secretary would be at the next Annual Meeting. It was broadening the basis generally of the Administration.

Mr. Howell wished to give a word of appreciation on the part of Members, Associate Members and Students of the valuable services that had been freely and willingly given by all the members of the Council; no one who had not had an intimate inside knowledge of the amount of work done, not only at Council Meetings, but at every hour of the day on the telephone answering questions, could know how much time had been sacrificed. The Annual Meeting was a fitting and proper place for the members publicly to express their appreciation of the valuable time given by the excellent men who represented the Institution. He therefore proposed a vote of thanks to the President, Vice-President and the Council for the excellent services they had rendered, and he hoped still would render, in making the Institution the leading Institution in the world.

Dr. Henderson asked to include in the resolution the officers of the Institution.

This was agreed to by the proposer and the motion was duly seconded and carried with acclamation.

The President said that, speaking on behalf of members of the Council and officials and himself, he could say that they did their best for the Institution and were only too pleased to do so. He thought the Institution had been very fortunate in finding members for the Council, and the members apparently had been extremely satisfied with the Council, because from the formation of the Institution there had never been a nomination from outside. Perhaps that was a matter the members would attend to in the future.

Presidential Address

Prof. J. S. S. Brame.

With the recent appointment of a special Committee of this Institution to deal with the questions of nomenclature and standardisation of methods of testing petroleum products, and the initiation on the Continent of discussions on the advisability of re-establishing the International Petroleum Commission, and an International Petroleum Institute at Strasbourg, it appeared to me that no better subject for my Presidential Address could be suggested than a resumé of this question. So much was attempted by the defunct Commission and so much has been accomplished in the United States in matters relating to standard methods and specifications that, in my view, the whole question requires careful survey and consideration at this juncture.

To-day, with disrupted threads of past activities carried hither and thither, we must particularly deplore the loss of our old chief and founder, Sir Boverton Redwood, who alone among our members could have gathered up the threads and made one coherent whole of them. I have not succeeded in accomplishing it to my satisfaction; there are gaps to fill for which I have not been able to procure the necessary information; there is the lack of personal contact with the activities of the past, which I had not and Sir Boverton had, with some of our other members. I hope, however, that my survey of the past and present activities in standardisation may prove of service to the Institution now that it has taken up this important question. Further, I trust that it will result in members giving consideration to the important question of the attitude which this Institution should adopt towards proposals for re-establishing some International body to deal with standardisation of nomenclature, testing and specifications of petroleum products. These matters might well form the subject for a most valuable and, I think, necessary discussion by our Institution. We came into being only in time to be present at the extinction of the International Petroleum Commission, as originally constituted, although Sir Boverton

Redwood and Major Cooper Key, of this Institution, and Sir Richard Glazebrook and one or two members of his staff at the National Physical Laboratory, had been actively associated with it. The work of this Institution during the few years of its existence justifies, however, its claiming to take no secondary part in any proposals which are being formulated for the resuscitation of an international body of petroleum experts to take up again the work which the International Commission dealt with.

International Petroleum Congresses were held in Liege and Paris (1900 and 1904), and Committees appointed to establish acceptable methods of analysis and testing of petroleum and its products, but little seems to have been actually achieved.

Another International Congress was held at Bucharest in 1907, and a small body of nineteen experts appointed to undertake the work; but this number was found to be far too small for such a task. In 1908, through the agency of the Berlin Foreign Office, it was proposed to the interested States that National Sections should be formed, and an International Petroleum Commission established.

The first meeting, at which the organisation and scope of the work was decided upon, was held in London in 1909, in connection with the meeting of the International Congress of Applied Chemistry. Each oil-producing country was to be entitled to two representatives on the Commission, with one vote in the final decisions. The scheme was to make certain members responsible for comparing methods in use for determining viscosity, flash points and fire tests, the determination of sulphur, paraffin, wax, etc. At the Vienna meeting (1912) the various reports were considered.

In a circular letter issued from the headquarters (Carlsruhe) of the Commission, of which Engler was President and Ubbelohde the Secretary, the organisation of the Commission was set out. National Groups were appointed, each with its independent organisation, and made up of representatives of Government Departments, Army and Marine Forces, railways, producers and consumers, commerce, scientific and research chemists.

The following countries were represented: Austria, Belgium, Bulgaria, England, France, Germany, Hungary, Italy, Netherlands, Norway, Roumania, Serbia, Spain, Sweden, and the United States. Russia was unofficially represented.

The original duties of the Commission were the same as those of the International Petroleum Congress, namely, to arrive at uniform methods of analysing petroleum and its products.

Each national group dealt with all questions concerning the

interests of its country, and drew up memoranda for submission to the International Commission, whose task it was to discuss the matters, try to arrive at uniformity, and promulgate the final decisions.

The financing of the Commission was by yearly contributions from the National Groups, which brought in 11,600 francs a year, and another 6,000 francs were given for special experiments.

At Vienna (1912) Engler suggested that in turn the various Groups should nominate the President. Ubbelohde, after giving a brief history of the Commission, explained that it was not expected that true uniformity would be established in testing, but that on considering the results from the different National Groups the Commission would be able to select the best methods. He also recognised that, whilst nomenclature should have a real scientific basis, consideration would have to be given to commercial usage.

At various meetings held Wiebe discussed the Abel flash point apparatus, Engler lectured on the separation of hydrocarbons, and Klaudy on prevention of fire in the storage of petroleum. Sir Boverton Redwood was elected an Honorary President.

At the Vienna meeting the tests for burning oils, petrols and lubricating oils were discussed, and certain standard methods agreed to by the majority of the delegates; but France and the United States did not accept the findings relating to burning oils and petrols. Certain matters, including changes of oils on storage; the high boiling constituents in petrol, its smell and colour; the evaporation losses, viscosity, capillarity, asphaltic contents, resistance to high temperature and air and steam of lubricating oils, and, finally, lubricating properties were all handed over to special commissions (?) or national sections.

In connection with the work done on flash point determinations, mention should be made of the valuable researches carried out at the National Physical Laboratory on behalf of the English section by J. A. Harker and W. F. Higgins. This work was considered by the Commission in 1912 (N.P.L. Collected Researches, VIII., pp. 19-39). Further work on different types of viscometers was similarly undertaken by Mr. Higgins, and the results have been published (N.P.L. Collected Researches, XI., pp. 1-16). We are fortunate in having Mr. Higgins as the representative of the National Physical Laboratory on our Standardisation Committee.

At the Vienna conference the scope of the Commission's activities was enlarged to cover all scientific and technical questions of importance. Special sub-committees were appointed to deal with International nomenclature (Allen, Edeleanu, Guiselin, Gurwitsch, Holde and Zaloziecki; later Ainsimann,

Ganc, Istrati, Poni and Ubbelohde also were included), with insurance questions, and with transport. For both the latter the nominations were Cupsa, Gutzu, Pfeiffer, Puscarini and Ubbelohde, but the National Sections were invited to nominate other representatives.

A resolution "That the International Commission may consider questions of storage and security against fire of petroleum products to be within the scope of their discussions" was carried, but England and Serbia did not vote, and the United States representatives were directly opposed to such extension of functions, which was their attitude also respecting questions of transport.

A perusal of the report on the Vienna meeting establishes clearly that material progress had been made, but one is left with the impression that the Commission had evolved too ambitious a programme.

The next meeting was to have been held in October, 1913, but for some reason was cancelled, and submissions were requested from the National Groups for the next locale for meeting to be held in the spring of 1914. England and the United States submitted London, for which nine countries voted, and Roumania submitted Bucharest, for which venue only France and Switzerland voted. As there was much delay in returning the votes the results were not issued until March 7th, and the meeting being proposed for April 4th–11th, no time was left for necessary arrangements.

Here this Institution came directly in touch with the International Petroleum Commission through our first President, Sir Boverton Redwood. Although we were almost in the prenatal stage, the interesting forthcoming event was known, and Engler and Ubbelohde referred to us as the fit body to organise the formation of an English National Section on the Commission, and Sir Boverton promised to bring the suggestion that the meeting should be held in London before the Council of the Institution. There can be little doubt but that the organisation of this projected meeting would have been one of the first duties devolving upon the newly-founded Institution of Petroleum Technologists.

Later it was decided that the Commission should meet at Bucharest in October, 1914. Although this Institution appears to have received no intimation from the headquarters of the Commission respecting this meeting, Sir Boverton Redwood had accepted an invitation to be present, and he and Major Cooper Key had been officially appointed as representatives of the British Government.

Needless to say, this meeting was never held, the outbreak

of war putting an end to the activities of the Commission, after a very brief existence, and I have not been able to trace any reports of the work of the special committees appointed at Vienna, which would presumably have been presented at the Bucharest meeting.

For this Bucharest meeting (1914) the Austrian Group had prepared a resolution in favour of the formation of a section to deal with statistics relating to the production and treatment of mineral oils, transport, consumption, fire accidents and legal regulations. Several National Groups had already collected much information in their own countries. The French Group proposed extension to include special regulations at ports respecting the discharging of petroleum cargoes.

Mons. A. Guiselin had submitted memoranda on the handling of petroleum at French ports and its transport to the interior.

Austria also suggested a special committee to collect and compare the regulations dealing with concessions and working of the same, with measures of safety (including insurance) in refineries, and to consider proposals for unification. It was submitted in support that regulations were often difficult to carry out and hampered the industry, because they were drafted by officials who were ignorant of the technicalities of the industry.

Some objection was taken by representatives to any action of the Commission relating to legal enactments and regulations on the ground that, there being in many cases representatives officially appointed by Governments, these Governments might in some way become bound by any decisions of the Commission; but Ubbelohde contended that this was out of the question, for any action of the Commission could only be advisory.

Towards the end of 1913 a proposal was put forward for the formation of an International Petroleum Institute. Ostensibly this suggestion came from the International Commission, but perhaps naturally it was assumed that the German Group originated the idea; but Ubbelohde was at some pains to combat this idea on the ground that the central organisation of the International Commission was quite independent of the German Group. It was urged that Carlsruhe was the natural home of such an Institution, because of the voluntary work already accomplished there, the scientific research on petroleum carried out, and the fact that foreign students had attended there for years. Further, it was the official headquarters of the International Petroleum Commission, and it was argued that an office was necessary for transacting the rapidly developing work and providing facilities for collecting and dealing with the literature and statistical material. Further, other advantages claimed for the Institute were that the already existing laboratories could

be expanded and would accommodate students of every nationality, who were to have equal rights.

It was contemplated that the necessary funds would be forthcoming from voluntary subscriptions from the industry and from various societies formed for studying oil problems, and it was also hoped that generous contributions might be forthcoming from Governments of countries having representatives on the Commission.

Sir Boverton Redwood was invited to become a member of the Committee, and Engler speaks of the Institution of Petroleum Technologists as the body best fitted to represent English interests.

In a letter dated April 4th, 1914, the Home Office laid the question of the International Petroleum Institute before this Institution, for observations and suggestions. It stated that a petition in favour of the formation of the Institute had been drawn up by the Commission and was supported by the German Government, and this was confirmed by the fact that the German Ambassador had put the matter through to the Foreign Office.

The matter came before the Council on April 28th, 1914, and the following occurs in the minutes :—

A letter from the Secretary of State for the Home Department dated April 4th, 1914, together with three enclosures dealing with the formation of an International Petroleum Institute was considered. The President referred to the honour which had been conferred on the Institution of Petroleum Technologists by the official recognition of its status and then gave a resumé of the occurrences which had led up to the present position. Ultimately after full consideration and some discussion it was resolved that a reply which had been drafted by the President should be sent."

This reply brings up another matter which caused more than a flutter in the Carlsruhe dove-cots, and that was that the Roumanian Ministry of Industry and Commerce proposed establishing an International Petroleum Institute in Bucharest. Announcements of this action had appeared in the *Moniteur du Petrole* (Nos. 35, 36, pp. 1572, 1618, 1619) and *Petroleum* (VIII., 554). The President was to be Professor Poni (the President of the Roumanian Group on the Commission), and the Vice-President, Professor Marazac.

The official letter from the Home Office to our Secretary referred to the receipt through H.M. Minister at Bucharest of an official intimation of the establishment of this rival "International" Institution, and our President, in his reply, referred to above, tactfully intimated that this Institution would prefer to

wait until the rival advocates had come to an agreement before taking any action.

At the end of April H.M. Minister in Bucharest intimated that further proceedings in the formation of the Institute there had been adjourned *sine die*.

This question of the formation of an International Petroleum Institute has been again revived by Mons. Ed. Schmitz. At the first annual meeting of the newly formed Petroleum Products Section of the Société de Chemie Industrielle at Paris last year, M. Schmitz discussed the past activities of the International Petroleum Commission and suggested that steps should be taken for its re-constitution. The formation of an International Petroleum Institute was also advocated on the ground of the continually growing importance of petroleum.

M. Schmitz, in his address to the Petroleum Section referred to above, claimed that such an Institute, once decided upon, would find its natural home in France, "a country easily accessible to all" and "which can have no interest in favouring the use of petroleum in a crude state, to the detriment of any other use." Further, he claims that Strasbourg is the right centre, because in 1920 a petroleum laboratory was started in the University there, "in the capital of the only French region producing mineral oil." The proximity of Pechelbron with its modern refining plant is another argument adduced in favour of this centre, which would also be the future headquarters of the International Commission.

It may be that this Institution will again be honoured by an invitation to express its views on the desirability of establishing an International Petroleum Institute, and possibly also of Government contributions towards such an Institute. Therefore it is most undesirable that your President shall have expressed publicly his own personal opinions, but I may perhaps pass some comment in general on the educational aspect of such an Institute. I look to the outstanding eminence of professors in one or more Universities attracting students and research workers as undoubtedly Engler and Ubbelohde did to Carlsruhe, rather than to the endowment of an International Institute. From the educational point of view I think it would be far more advantageous to expend money in founding national or other scholarships, so that suitable men could study petroleum problems in whatever University the eminent teachers might be.

Reverting to the question of the International Petroleum Commission, M. Schmitz in his address to the Petroleum Products Section of the Société de Chemie Industrielle pointed out the lack of success which had attended his appeals to the French National

Group in *Les Matieres Grasses* and other journals to re-establish connection with other National Groups. In a later issue of the same journal (No. 165, January 15th, 1922, p. 6033) he outlines a programme for reviving the Commission. Briefly it is that the Société de Chemie Industrielle (founded 1918) should appoint a committee of French chemists from the Petroleum Hydrocarbon Section, and that this body shall get into touch with other National Groups and arrange to continue the work of the Commission. It is claimed that the Société de Chemie Industrielle will afford a secure foundation, being affiliated as it is with the International Congress of Pure and Applied Chemistry.

One is tempted to ask whether too much stress is not generally laid on the chemical side, to the almost total exclusion of other factors. As a chemist I do not fail to recognise the outstanding importance of chemistry to the industry, but is petroleum technology to be interpreted in such a narrow sense that it is but a branch of technical chemistry? If so, the existence of this Institution is not justified; we ought to be a "group" of the Society of Chemical Industry. Perusal of the files of our Journal will quickly dispel such an idea, and I feel some protest is called for against an apparent attempt to harness any International Petroleum Commission or Institute exclusively to a chemical chariot. The question will naturally arise, what is to be the attitude of this Institution towards a resuscitated Petroleum Commission? Possibly the key is to be found in the following somewhat biting sentence from M. Schmitz's address to the Petroleum Products Section of the Société de Chimie Industrielle last year: "The Americans only have continued their pre-war work, and profiting by the general disorganisation and confusion, they evidently seek to abandon the analytical methods previously decided upon, in favour of their own." This sentence probably hardly does justice to the United States, for they did not subscribe to the whole of the recommendations of the International Commission in respect to testing and analytical methods. Further, their representatives directly protested against certain of the questions which were submitted for consideration, such, for example, as those which might affect legislation.

I cannot believe that the largest oil-producing country in the world, which has rightly devoted through its excellent organisations much money, time and labour to the investigation of petroleum problems, in its official and unofficial laboratories, is likely to depart readily from the methods which it has elaborated and adopted. In the U.S. the Government Department of Geology and the Bureau of Mines, together with the splendid organisation of the American Society for Testing Materials, have collaborated and developed a number of methods, which although

at present only designated as "tentative," may, I believe, be taken as the last word, except for minor modifications, the United States will have to say on methods of testing and analysis. I propose dealing briefly with what has been accomplished in the States.

The valuable Petroleum Technology Bulletins published by the U.S. Bureau of Mines are so familiar to our members that nothing beyond this reference to them is called for, but I propose dealing in outline with the work of the American Society for Testing Materials, a Society to which our Institution has recently become a subscribing body. In the future it will be possible for our members to get access in our library to the valuable publications of this Society, which will not only be of the greatest service in purely petroleum matters, but afford information to our engineer members on all kinds of structural materials.

The American Society for Testing Materials had its origin in the American branch of the International Association for Testing Materials, and adopted its present name in 1902. At its first annual meeting its membership was 70, in 1921 it numbered just under 3,000, with subscriptions amounting to 40,000 dols. per annum, and with proceeds from the sale of its publications amounting to 11,000 dols.

In 1903 (Vol. III., 349) the first reference to petroleum products occurs in a contribution by A. W. Dow on Testing Bitumens for Paving Purposes. In 1904 Committee N. on Lubricants was formed, and in 1905 sub-committees of this main one were established to deal with (*a*) threading oils for cutting bolts and pipes; (*b*) the best methods of making viscosity tests; (*c*) the use of friction testing machines in determining the actual lubricating value of oils; (*d*) oil analysis; (*e*) cold tests for oils and the melting point of greases; (*f*) specifications. In 1907 the Lubrication Committee (N) reported, and arrangements were in progress for sending out oil samples for investigations to be made of the flash point and fire tests, cold tests, and specific gravity determinations.

At the annual meeting in 1909 a "session" was devoted to Bitumens and Oils, and nine papers were presented. A sub-committee (X) was appointed to deal with Standard Methods of Analysis of Fats and Oils, and another (Y) for Insulating Materials.

The Lubrication Committee (D^2) reported on Viscometry in 1910 and expressed a strong preference for the Engler instrument, as recommended by the International Committee for testing lubricants, but in 1914 this was reversed in favour of the Saybolt instrument. In 1915 Dr. C. W. Waidner (U.S. Bureau of

Standards) published his valuable tables of comparison for the Saybolt, Redwood and Engler viscometers (1915, p. 284) and the methods recommended for Viscosity, Specific Gravity, Cloud and Pour tests were referred to members for ballot. The other subjects still under consideration were Saponification Value, Carbon Residues, Evaporation, Emulsification, Precipitation, Flash Points and Fire Test and Gumming.

In 1917 "tentative" methods for these latter were submitted to the members (pp. 463, 767), and in the subsequent year the Lubrication Committee (D^2) was considering the standard temperatures at which viscosity determinations should be made, and reported on evaporation tests. A sub-committee on Paint Thinners reported in favour of the use of the Tagliaubue tester for flash point determinations, and in 1919 three more sub-committees were appointed to deal with Petroleum Distillates, Tar Distillates and Sulphur Tests, and the Lubrication Committee (D^2) submitted full details for the Saybolt Standard Universal Viscosimeter (1919, p. 728.) A report of a sub-committee of the Lubrication Committee (D^2) reviewed in 1920 the methods of determining sulphur.

Last year a notable departure was made, for the eighth session of the annual meeting was devoted to Petroleum Products and Lubricants, and Committee D^2 now includes the former in its scope, whereas hitherto these products have been incidentals to the work of other Committees.

This Committee has a total membership of 58, 30 representing non-producers and the balance producers, and at the 24th annual meeting (June, 1921) reports from 16 sub-committees were presented. The subjects reported on comprised (I.) Petrolatum, (II.) Gas Absorbent Oil, (III.) Paraffin Wax, (IV.) Grease, (V.) Viscosity, (VI.) Colour, (VII.) Sulphur Determination, (VIII.) Distillation, (IX.) Precipitation, (X.) Oxidation at High Temperatures, (XII.) Flash Point and Fire Test, (XIII.) Saponification, (XIV.) Water and Sediment, (XVI.) Cloud and Pour Tests. (The Roman figures are the sub-committee designations.)

The Department of Standards and Tests of the National Petroleum Association (U.S.A.) submitted these reports to the whole of the industry last year, and the standard test for Flash Point of Volatile Liquids, together with eight others of the twelve contained in the Report of the Petroleum Products and Lubricating Oils Committee, were accepted, but the N.P.A. Committee requested the A.S.T.M. Committee to consider further four of the methods.

It may prove of service if I give the complete list of methods and standards submitted in the recommendations of the Standard and Tests Committee of the National Petroleum Association :—

(1) Gravity.
(2) Distillation of Gasoline, Naphtha, Kerosene and similar Petroleum Products.
(3) "Doctor" Test (sodium plumbite) for Gasoline, Naphtha, Kerosene.
(4) Tests for Mineral Acids in Gasoline.
(5) Flash Point of Kerosene, other Burning Oils, and other Petroleum Products of comparatively low Flash Point.
(6) Burning Test for Kerosene.
(7) Colour Test for Gasoline, Naphtha, and Kerosene.
(8) Floc Test for Kerosene.
(9) Sulphur Determination in Naphtha and Illuminating Oils.
(10) Viscosity of Fuel Oil, Road Oil and Fluxing Oils.
(11) Calorific Value of Fuel and Gas Oils.
(12) Distillation of Fuel and Gas Oils.
(13) Determination of Water in Petroleum Products.
(14) Determination of Water and Sediment by means of Centrifuge.
(15) Determination of Sulphur in all Oils except as in (9).
(16) Colour of Lubricating Oils.
(17) Viscosity of Lubricating Oils.
(18) Flash and Fire Points of Lubricating Oils.
(19) Carbon Residue.
(20) Cloud Test and Pour Test.
(21) Free Acid Test.
(22) Precipitation Number (tar test) of Lubricating Oils.
(23) Free Sulphur and Corrosive Sulphur Compounds.
(24) Pensky-Martens Closed Cup Flash.
(25) Saponification Number.
(26) Melting Point of Paraffin Wax.
(27) Temperature Measurements in Oil Testing.

It was believed at the latter end of 1921 that the U.S. Inter-departmental Committee on Standardisation of Petroleum Specifications would adopt all of the tentative and standard testing methods recommended by Committee D^2, and the Society of Automotive Engineers also accept the A.S.T.M. methods.

My own personal view is that the successful work which has been accomplished in the United States establishes the methods already "tentatively" issued in such a firm position that I cannot believe the petroleum technologists there would be disposed to submit to the possible scrapping of much of its work by any new International Petroleum Commission.

When this Institution set up its Standardisation Committee last year I wrote to the Secretaries of the American organisations dealing with such questions, expressing the hope that we might

work together in a spirit of hearty collaboration The replies received have been most cordial, and we may look forward with every confidence to an exchange of results and opinions which must be to our mutual advantage and the benefit of the industry. I believe that it is of the greatest importance that the two great English-speaking countries, one the greatest producing country, the other with enormous oil interests in all parts of the world, shall collaborate in arriving at a system of nomenclature and at acceptable specifications which will be adopted wherever the English language is spoken. In the analysis and testing of petroleum and its products we may hope also, by the avoidance of a too dogmatic insistence on details, to arrive in nearly all cases at Standard Anglo-American methods. There will be special cases, like the use of different types of viscometers and flash-point apparatus, where owing to established custom change by either country would entail considerable disorganisation. By scientific comparison of the respective instruments it would be possible to establish true comparisons, and, different as the instruments might be, there would be no ambiguity about the results.

If agreement on these lines is reached, I cannot see the advantage which will accrue to the countries having by far the largest interests in mineral oil from the reincarnation of an International Petroleum Commission. If the Continental nations decide to revive the Commission, and agreement is reached by America and England independently, the voices of those two countries in unison would carry much weight in its deliberations, if it was decided to accept any invitation which might be extended to them.

A vote of thanks having been accorded to the President, the meeting closed.

The **Sixty-third Meeting** of the Institution of Petroleum Technologists was held at the Royal Society of Arts on Tuesday evening, April 11th, 1922, Sir Thomas Holland, K.C.S.I., K.C.I.E., occupying the Chair.

Members of the Council present were:—Sir Frederick W. Black, Herbert Barringer, E. H. Cunningham Craig, Dr. A. E. Dunstan, Arthur W. Eastlake, James Kewley, and Robert Redwood.

The following paper was read:—

Galicia and Its Petroleum Industry.

By ALBERT MILLAR, A.M.I.MECH. E.

I WISH to tender my most sincere thanks to Mr. M. Ockenden and Mr. Ashley Carter for their valuable assistance in revising this paper, and to Dr. K. Tolwinski, Chief of the Boryslaw Geological Institute, Dr. W. Rogala, Professor of Geology at the Lemberg University, Mr. H. R. Wright, H.B.M. Vice-Consul in Boryslaw, and Mr. C. MacIntosh in Strjy, Galicia, for the very valuable information they have given me in preparing this paper.

INTRODUCTION.

IN this paper relating to the Galician Petroleum Industry, it is intended to deal principally with the largest oilfield exploited up to the present, that known as the Boryslaw-Tustanowice-Mraznica field, as this is the point of concentration where most important progress has been made.

The Carpathian mountain range traverses Galicia for nearly 480 kilometers in length, extending from beyond the source of the river Vistula in the west to the source of the river Pruth in the east, thus forming a natural southern boundary. Along practically the entire stretch of the northern slopes of this mountain range throughout Galicia, bituminous deposits consisting of mineral oil, natural gas, ozokerite and coal have been found. Oil has been located in more than 420 different places, and over 170 oilfields which have been proved exist to-day. As will be seen from the accompanying map of Galicia the oil-belt, about 400 kilometers long and approximately 50 kilometers wide, commences near Krakau, and continues more or less regularly to the eastern boundary and thence on through Roumania to the Black Sea.

Western Galicia has been renowned for its many excellent oilfields producing a high-grade oil with paraffin base containing, on an average, from 15–40% benzine, 20–35% kerosene, the remainder being lubricating oils and paraffin. The production is obtained from depths varying between 150–700 meters and deeper, and the wells produce steadily over very long periods. It is not at all unusual for them to yield after thirty years and more continuous exploitation. Amongst the many well-known Western Galician fields the following are worth mentioning :—West of the River San: Bobrka, Kryg, Kroscienka, Weglowka, Wietrzno, Humniska, Starawies, Harklowa, Rogi, Iwonicz, Rowne, Klimkowka, etc. East of the River San: Rajskie, Polana, Unerce, Ropienka, Wankowa, Lodyna, Paszowa, Starzawa, Bandrow, Horszow, Schodnica, Urycz, etc., Kropiwnik, etc.

In East Galicia the village of Sloboda Rungurska was the first place where wells were sunk by mechanical means, although many oilfields had already been proved to exist by reason of hand-dug and drilled shafts exploited by the local peasantry from the year 1770 onwards. Since then Bitkow, Rypne, Starunia, Dzwinacz, etc., have been opened up and partly developed, pioneer work is being carried out in other districts, and there is not the slightest doubt that East Galician territories will play a very important part in the near future, especially as many prospectors share the belief that Boryslaw-Tustanowice-Mraznica is nearing exhaustion, and hold out great hopes in respect of oil-bearing territories between the San and the Pruth Rivers.

The reason why Eastern and Western Galician properties did not receive the attention they justly merited was due to the fact that Boryslaw-Tustanowice with its large producers came in at a time when the demand for crude oil and its products was not so great as it is to-day. Other oilfields with their smaller productions of high-grade oil could not compete with the big flowing wells of this new field, which flooded the market and brought down the price of crude to a disastrous point, during 1908–1909 it fell to the extraordinarily low figure of 7s. per ton, and some contracts were even passed at 5s. per ton. When eventually the price of crude oil improved, Boryslaw-Tustanowice became the centre of attraction for investors, consequently outside oilfields were closed down one after another.

The advantageous situation of the Galician Oilfields, both from a prospecting and commercial point of view, is an envious one. It is surrounded by industrial countries requiring enormous quantities of petroleum and its products. There is a good network of railways serving the different States, and railway facilities both as regards passenger and goods service, are rapidly improving. With the constantly increasing demand for petrol, kerosene, lubricants, etc., etc., no difficulty whatever is experienced in disposing of either the crude oil or refined products, especially as the Polish Government is now trying in a number of ways to assist the industry.

The importance this central European oilfield played during the war was hardly sufficiently appreciated, but its value was fully recognised by the Central Powers, who, with their wonderful means of organisation did everything in their power to assist and stimulate the industry. Lack of rubber, like many other things, was very badly felt, and it may be of interest to quote the fact that the German Submarine "Deutschland," which reached America in 1916, brought back a cargo of first-class rubber, which was manufactured into rubber rings for swabbing the wells. These were marked "U" (Unterseebot) and came in just at a time when this commodity had become practically exhausted, and very highly

adulterated rubber or rubber substitutes had proved far from satisfactory. As the production from 95% of the producing wells is obtained by means of the swab (fitted with rubber rings) it will be seen by the efforts made by the Central Powers to supply the industry with its needs, what value they attached to the Galician Oilfields, especially Boryslaw-Tustanowice-Mraznica. Although drilling was to a certain extent curtailed owing to lack of materials, everything possible was done to keep the producing wells working.

Whilst dealing with the Petroleum industry of Galicia, it would hardly be fair to omit mentioning the Galician driller, who plays such an important part in the routine.

The average Galician Driller of to-day does not come up to the pre-war standard in regard to work accomplished; the reason for this is partly due, as in every other country, to the demoralising effects of war and its reflection on "labour" generally.

The Galician driller, however, possesses that trait so often found amongst the Slavs, of being able to quickly adapt themselves to almost any condition, and it is surprising the endurance these men have, and the fortitude with which they have borne all kinds of hardships.

History.

As far as can be traced from authentic records, the town of Boryslaw has been associated with the exploitation of bituminous minerals since the early part of the nineteeth century, although mention has been made by Professor Balthazar Hacquet of crude oil from Nahujowice, near Boryslaw, being used as far back as 1794 as axle-grease and a medicant for cattle.

In 1810 Hosepf Haecker, an Inspector of the Drohobycz Salt Mines (a district town about ten miles to the north of Boryslaw) entered into partnership with John Mitis for the purpose of obtaining crude oil by means then accessible, which they intended putting through a process of distillation. A small refinery sprung into existence in Hubice, a village near by, where a distillate of some kind, resembling kerosene, must have been arrived at, inasmuch as the Municipality of Prague entered into a contract in 1817 with these refiners for the supply of 30,000 klgs. of this distillate, destined for lighting the streets of that town. Difficulties of transport proved a stumbling block, and owing to the Company being unable to fulfil their obligations regarding time of delivery, etc., the contract was eventually annulled, and thus the first attempt to establish a refinery as a commercial enterprise and to use kerosene as an illuminant, did not materialise.

Amongst the Mining Archives of Drohobycz there are records of permission having been granted in 1831 to J. Miczewski to carry out research work and to mine "Bergtaer" (Earthtar).

Similar permission appears recorded in the enactments of the Drohobycz Kameralamt in 1843.

In 1852 Ignacz Lukasiewicz, a Galician Pole by birth and by profession a pharmaceutical chemist of Lemberg, with two companions, R. Doms and J. Zehe, experimented with samples of liquid submitted to them by a Boryslaw Jewish vendor of cartgrease, named Schreiner, which liquid had been formed by the condensation of gases produced whilst heating the crude oil in a covered reservoir during the manufacture of cartgrease.

After a series of tests, the chief of which was the treatment of this sample with sulphuric acid and caustic soda, an excellent illuminant was obtained. Upon recognising the value of this discovery and the important part it would play in the future, Lukasiewicz, together with his companions and a Lemberg chemist named Mikolasch (a man of considerable means), founded a company and erected a still, the first definitely known to have been built in Galicia. They purchased stocks of crude oil in Peczenizyn, which had been collected by the peasants from hand-dug wells in that district, and in which oil they had recognised similar qualities to that produced in Boryslaw. This refinery, primitive as its equipment must have been, achieved a certain degree of success, as shortly afterwards lamp-oil was introduced as a commercial commodity. In 1853 the Lemberg Hospital was lighted by this means. A little later a second refinery was established in Boryslaw by Schreiner under the supervision of Lukasiewiez, and they contracted for lighting the Vienna Northern Railway Terminus. In 1854 R. Doms discovered rich deposits of ozokerite in Boryslaw, from which wax candles were manufactured by Lukasiewicz and Zehe. This, however, is not the first record of wax candles being produced, as there is evidence amongst the Mining Archives that John Mitis manufactured candles from ozokerite in 1817. Their general use does not seem to have been adopted.

The kerosene produced by Lukasiewicz was burnt in open vessels, with floats through which twisted wool was drawn to act as a wick; this was exceedingly smoky but a great improvement on previous illuminating methods. In 1854 a tinsmith named Bratkowski constructed the first petroleum burning lamp, which was placed on exhibition in the window of Mikolasch, the chemist, in Lemberg. This proved a very progressive step, and eventually, when this burner was still further improved and a chimney introduced, it was considered that nothing better could be achieved. It appears that about this time an improved burner was also made by the firm of Stobwasser, of Berlin.

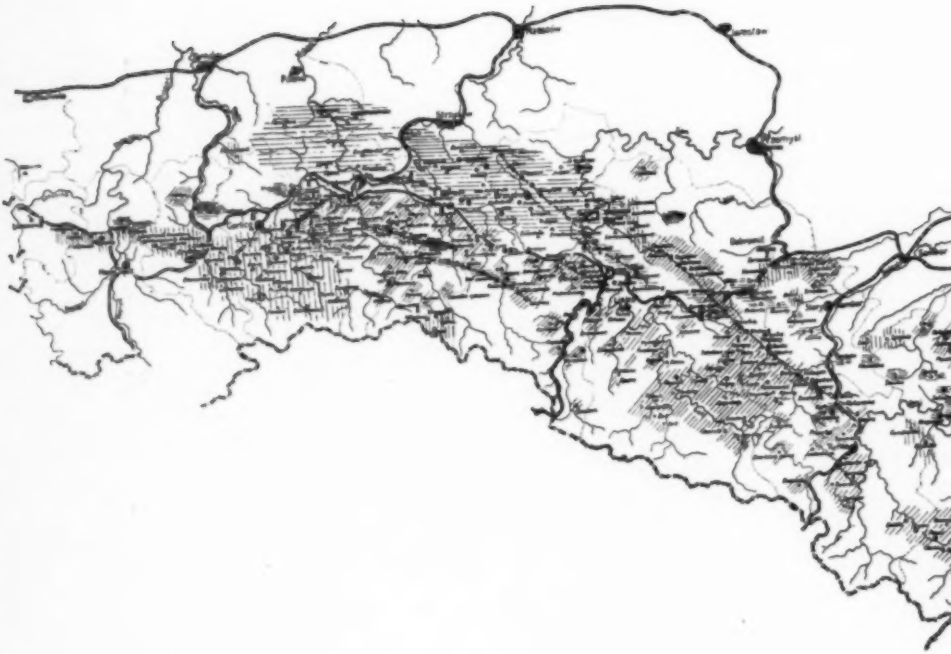
Owing to lack of funds, Lukasiewicz's first undertaking was liquidated and after a time he moved to Gorlice in Western Galicia, where he resumed his profession as a chemist. At this time on

search being made for asphalt, oil outcrops were discovered near Gorlice by a Mr. Titus Trzecieski (whose name afterwards became closely associated with the development of the oil industry), the latter had been acquainted with the existence of oil outcrops near Bobrka for some time, and had made exhaustive enquiries whether any other use than that known to him (either as grease or medicant for cattle) could be found for this "Erdfett" (earth-fat), but could get no one interested until he met Lukasiewicz. Trzecieski informed the chemist that this commodity could be obtained in large quantities from the peasants of Bobrka. Lukasiewicz lost no time in proving the benefits to be derived by the distillation of crude oil, and demonstrated its illuminative powers when burned in an improved lamp.

In 1854 these partners commenced to dig their first well in Bobrka, and thus opened up what eventually proved one of the most productive Western Galician oilfields. These hand-dug wells were several feet deep and the oil was collected by skimming it off the water as it accumulated. It was soon discovered these wells were not deep enough; therefore after passing through the gravel in the usual manner and reaching the sandstone, they used a beam with a forged iron head as a drilling implement, and were thus able to reach a depth of from 20–50 meters, these wells being lined with wood to prevent caving. During succeeding years a number of these shafts were sunk, some to nearly 100 meters, but work at this depth was greatly handicapped owing to the gas imperilling the lives of the workers. In 1858 the hand-dug well "Margaret" was brought into production at 60 meters with 3000 kilos. of oil per day. In the same year these undaunted pioneers built a refinery near Jaslo, which was completely destroyed by fire three years later. Another refinery was erected at Polanka, but this was also partly or wholly destroyed by fire on more than one occasion.

1862 witnessed an important step forward as far as drilling was concerned, when a drill was used in conjunction with "freefall" jars (system Fabian), and they were successful in drilling a well by means of this improved set of tools to over 250 meters without serious mishap, although drilling progressed very slowly and did not average more than 20 centimeters daily. This well "Walter" still produces a small quantity of oil at the present time.

Mr. W. H. MacGarvey introduced the Canadian drilling system in 1884, and the first well to be drilled by this means was at Wietrzno, in Western Galicia, when a depth of 378 meters was attained. He also employed hermetical casing for shutting off water before reaching the oilsands. Although previous to 1884 considerable progress had been made and many oilfields opened up, it was not until the successful results obtained by the Canadian method of



MAP OF THE GALICIAN OILFIELDS.

Oil Seepages
Hand dug research shafts
Hand dug shafts formerly in ex.
Drillings carried out
Old producing wells
Fields at present being exploited
New fields being opened up
Refinery's
Gas Wells
Ozokerite
Oil found in Cretaceous
Oil found in Eocene
Oil found in Oligocene
Bukowina

ELDS.

drilling, that the Galician petroleum industry received the real impetus it required.

The peasants of Boryslaw were the first actual exploiters in this district. They used to collect the oil from hand-dug pits along the Tysmenica river and after whipping the oil in shallow trenches by means of willow twigs, to rid it of its lighter constituents, the product was transported in small barrels to the neighbouring town of Drohobycz, where it was sold as cartgrease under the name of "Ropa." The lighter crude oil called "Kipiaczka" was disposed of to neighbouring tanneries for waterproofing leather. Between 1885–1892 hand-dug wells in the Boryslaw district produced as much as 5000 kilos. of oil per week.

The Boryslaw Petroleum Industry did not make much progress until the well-known and successful pioneer, Mr. W. H. MacGarvey, introduced the Canadian system of drilling into this district, in the year 1892–1893, when the industry began rapidly to make headway. It was due to the great tenacity of this gentleman and his little band of pioneers that by 1903 the oil industry had been developed to such an extent that specially equipped refineries had been built to distil and refine the Boryslaw crude oil, which is a heavier grade oil to that produced either in Eastern or Western Galicia.

Boryslaw-Tustanowice-Mraznica is situated on the outflanks of the Carpathian Mountain range and yields over eight times the total output of all Western and Eastern Galician fields combined, being at the present time one of the most important industries of the Polish State. The area of this field is approximately from 24–25 square kilometers, the average width being from $3\frac{1}{2}$–$4\frac{1}{2}$ kilometers, and its length approximately 6 kilometers.

Of some 170 oilfields proved throughout Galicia since 1884, only about 80 are being worked at the present time.

In spite of the fact that the production of Boryslaw-Tustanowice has been steadily on the decline for several years past, there is great drilling activity in the Mraznica and Hordyscze districts and prospecting work goes rapidly ahead, notwithstanding the probability of wells having to be carried down to between 1400 and 1800 meters or even more, according to location, before striking the Ciezkowicer or Boryslaw sandstone, which has proved to be the most prolific formation up to the present in Boryslaw-Tustanowice. Time and the drill may prove that the various oilbearing strata of the Menelit series, which in the majority of cases in Northern Boryslaw only yielded what may be termed "good shows" or, occasionally, small productions—(2–4 tons per day) may be more richly charged with oil, the further one proceeds to the south in the direction of the dip.

The first part of Boryslaw to be exploited was known as the "Potok," where Mr. MacGarvey located his first well in 1892. This

well was drilled to nearly 400 meters, but had to be abandoned before oil was struck owing to spiking and casing trouble. The latter difficulty was caused by the ozokerite beds having to be drilled through, the semi solid ozokerite being forced up inside the casing by lateral pressure which prevented the casing being carried down. His second well reached nearly 500 meters, but owing to the small dimension of the casing, only 2¼ ins., it had also to be given up. Still undaunted he commenced a third well, which was successfully drilled to oil at approximately 600 meters with 5 ins. hermetical casing, the production being about 10 tons per day eruptive. Within a very short time three more wells were brought in, each yielding from 10–15 tons per day, and it was then that wells were sunk rapidly one after another.

Gradually the sphere of drilling operations spread outwards on all sides, and in 1902 a well-known pioneer, Dr. Szujski, surprised the oil community by commencing to drill a well in Tustanowice, which was at that time considered to be a remote district, with little likelihood of proving oil-bearing. This was known as the "Litwa" well and commenced drilling in 1902, coming into production in 1903 at nearly 1000 meters, with about 300 tons per day.

Owing to the very low price of oil and the cost of drilling deep wells, only those yielding very large productions could be made to pay, and as Tustanowice gave every prospect of bigger production, work was concentrated on this part of the field. In 1904 and 1905 a great deal of capital was lost owing to the low price of crude and lack of storage and export facilities. 1906 showed no improvement and 1907, when the "Wilno" well was drilled to oil at 1060 meters, with a production of from 700 to 800 tons per day, the price of crude fell to a disastrously low point. Lack of storage compelled producers to get rid of their oil at any price, and the industry was faced with ruin, as there existed no organization for dealing with a production which increased by leaps and bounds. Large quantities of oil ran to waste. In December, 1908, the production of Tustanowice was 123·390 metric tons, as against 18·680 m.t. for Boryslaw.

Producers and prospectors interested in this new field, instead of endeavouring to cope with the situation, withdrew, afraid of what the future might bring. The Austrian State then took the matter up and commenced to build large earth reservoirs (ambars). Hardly had the effects of the eruptive "Wilno" and other wells been partly contended with, when "Oil City" came in with an eruptive production of from 1500–2000 tons per day, afterwards settling down to 1000 tons. The greater part of this production flooded the surrounding district and ran to waste. Improvised earth reservoirs were hastily dug, but it was almost impossible to deal with the constantly increasing stream of oil.

Geology.

Galician Oilfield geology offers probably one of the most complicated subjects of its kind and forms a very interesting study. Oil has been located in approximately 400 different places, and each of these constitute a problem in itself. It is impossible in limited space to attempt even a brief description of the geology of individual fields, therefore efforts will be confined to a short description of the geology of the Boryslaw-Tustanowice-Mraznica field.

Before entering on this subject, however, it may be stated that petroleum is found throughout Galicia in four geological series: Miocene, Upper and Lower Oligocene, Upper and Lower Eocene, and Cretaceous. The Miocene series has produced a comparatively small quantity of oil, and it is questionable as to whether its presence in Miocene beds is indigenous to that deposit or due to infiltration from immediately subjacent rocks. Up to the present the Oligocene series has produced the greatest quantity of oil, the second most productive series is the Eocene, after this comes the Cretaceous; but this latter has not yielded to the same extent as the Oligocene and Eocene.

Oil has been located throughout Galicia in 70 different places in Cretaceous formation, 130 in Eocene, and over 200 in Oligocene. There are a number of localities where oil has also been found in Miocene, but this is usually in conjunction with ozokerite.

It is generally believed that fossilized remains (fauna) are of rare occurrence; this does not, however, appear to be the case. The late Dr. Rudolf Zuber devoted much time to research work in this particular direction, and at the time of his death had gathered together a most interesting and valuable collection. This work is being carried on with untiring energy by Dr. W. Rogala, Professor of Geology at the Lemberg University, who states that fossilized remains are to be found in all the geological series throughout Galicia, consisting chiefly of ammonites, gasteropoda and foraminifera.

The geological formation of the Boryslaw-Tustanowice-Mraznica field is as follows:—

(*a*) Alluvium and diluvium, clays and gravels approximate thickness, 5–20 meters.

(*b*) Miocene series. Salt formation, average thickness about 300–500 meters, depending on locality; this consists of grey clays, gypsum, shale beds of a light grey colour, and thin layers of soft sandstone. The well-known Boryslaw ozokerite deposits are found in this formation.

(*c*) Upper Oligocene, also known as the Dobrotower formation, approximately 350–400 meters thick. Owing to its very close

resemblance to the Miocene it is very difficult to determine exactly the point of contact. This formation chiefly consists of laminated clays and shales, light and dark-grey shale beds, sandstone and conglomerate containing mica and calcareous matter.

Petroleum charged sands are fairly frequently met with, but the quantity of crude oil obtained is not generally in sufficient quantity to pay for its exploitation, although in the northern parts of Boryslaw and Tustanowice, a number of wells struck quite good production of from 5–30 tons per day in this series.

(*d*) Lower Oligocene, known as the Menilite formation, thickness about 150–250 meters, consisting of layers of sandstone of varying thicknesses, both fine and coarse grained, beds of brown and black shale and layers of flint (known locally as Hornstein); the latter being exceptionally hard and varying in thickness from a few centimeters to as much as 2 and 3 meters. This overlays what has hitherto been the most productive sand of the Boryslaw-Tustanowice field.

(*e*) Boryslaw Sandstone. Also known as the "Basal or Ciekowiczer" sandstone; the thickness varies in different parts of the field from 20–50 meters, and is mostly composed of fine almost white particles of sand well cemented together.

(*f*) Upper Eocene. This series lays below the "Boryslaw sandstone," but the point of contact with the lower oligocene is difficult to determine owing to its close resemblance, and in practice the appearance of green shale is generally taken as the commencement of drilling in the upper Eocene. The thickness of this series is between 200–250 meters, with grey and green sandy shales interstratified with thin layers of hard sandstone; also loose sands which have yielded very good productions in some wells; but examining the results of borings over large areas, this, although known as the second oil horizon, is erratic. In some cases this formation has been found to contain considerable quantities of water.

(*g*) Lower Eocene. This formation, about 200 meters thick, consists of green shales, sometimes red shales and clays, very hard fine-grained quartz sandstone, also known as the "Hieroglyphic" sandstone. At the base of the Lower Eocene "Jamna" sandstone belonging to the Cretaceous series is reached; before, however, the point of contact of the Lower Eocene with the Jamna sandstone, the third, and up to the present, the last known oil horizon is struck, its productiveness depending on the thickness of the oil-sandstone which varies considerably in different parts of the field. Some wells are producing large and steady quantities of oil from this horizon. Water is also met with in this formation.

(*h*) Upper Cretaceous. Thickness about 200–250 meters, consisting chiefly of the "Jamna" sandstone which is both fine and

A VIEW IN THE MRAZNICA VALLEY.

ANOTHER VIEW IN THE MRAZNICA VALLEY.

coarse-grained, beds of green sandy shales and clays in which are found embedded boulders. So far, very few wells have been drilled into this sandstone and none to any appreciable depth.

There is great diversity of opinion as to whether the Upper Cretaceous formations will eventually prove to be oil bearing or not, many eminent oilmen being of opinion that the Jamna sand will prove to contain much water. The chief reason why wells have not yet been sunk deep into this formation is the fact that at the shallowest depth it is met with at about 1400 meters, and in the south of Boryslaw nearly 1800 meters. Before, this depth could not be reached, as the diameter of the casing in the older wells was already of such small dimensions as to render the continuation of drilling a very tedious process, even could it have been carried on. It may be that in the future some of the more up-to-date wells, after having exhausted the Oligocene and Eocene oil-bearing strata, will have a sufficiently large diameter casing to allow drilling to be continued into this formation to a reasonable extent, as it has been proved both in Eastern and Western Galicia, that the formation of the Cretaceous series is oil-bearing.

The geological formation of the Southern part of Boryslaw, Tustanowice and Mraznica, varies considerably from that of the north, owing to what is known as the Carpathian Overthrust Fault

This overthrust is made up of the Oligocene, Eocene and Cretaceous formations. Much greater difficulty is experienced in drilling in Mraznica than in the other parts of the field; this is accounted for by the formations composing the thrust (Eocene and Cretaceous) being very broken up in this area. The thrust is first encountered in the central part of the Boryslaw-Tustanowice field, where it overlays the regular Boryslaw series. At this point the thickness is comparatively only a few meters, but the further to the south one proceeds the thicker becomes the formation composing the thrust. In Mraznica and South Ratoczyn (Western Boryslaw) oil is produced from the overthrust and has a higher specific gravity than that emanating from the Boryslaw sand. According to tests carried out by Ing. Wielezynski the former has a specific gravity of 0·8830 at 15° Cels., and the latter 0·8545 at 15° Cels. The oil from the overthrust contains 0·61% of paraffin wax, and that from the Boryslaw sand up to 10·4% of paraffin wax. Further tests carried out by Ing. Wielezynski and Dr. Dolinski, shows that the deeper one drills the lighter the specific gravity of the oil obtained, whereas on the other hand up to the fourth horizon (Boryslaw sandstone) the percentage of paraffin wax increases until it reached 10·3%, from that depth onwards it gradually decreases to about 7·3%.

The Boryslaw sandstone is not saturated with oil throughout its entire thickness, as is proved by the fact that a number of wells in close proximity derive their production from different

depths in the sandstone, whilst some wells remain altogether non-productive, often only slight traces of oil and gas being encountered when drilling through this sandstone.

It would appear that most of the producing wells derive their production from fissures or crevices, the amount and duration of production depending on the extent to which the sandstone is broken up; therefore it is quite possible that wells could be drilled into this sand which would be dry holes, whereas probably within a few meters there may be a crevice or series of crevices containing quantities of oil. Another point favouring this theory is that wells have been drilled into this sand without finding more than a trace of oil, whereas other wells a few meters distant have a good production. Swabbing has been resorted to, and in some instances, after weeks of continuous work, the oil which at first showed itself in mere traces has gradually increased until it became a steady production, an output of from 50–60 tons per day having been obtained. It is obvious that had the operators relied on a flow or a production as the result of a trial swabbing, instead of the continuous action of the swab, the well would have been non-productive. Naturally, should the oil-bearing crevice or fissure be some distance from the bore-hole, with no communication to same, the probability of drawing the crude oil in or opening up a channel would be fruitless, which is probably the explanation of so many dry or nearly dry holes amongst the producing ones.

In the Horodyscze section of the field, results have been very far from expectations, and it would seem that the Boryslaw sandstone is less broken up here than in any other part of the field. Many wells have drilled through the sandstone, which should have been oil-charged, and have not produced a ton of oil, although every chance of obtaining production has been tried out.

Watering of the Tustanowice Field and its Consequences.

The watering of the Tustanowice field, where over a confined area there were a number of producing wells, nearly all flowing and giving an average production of between 150–200 tons per day, was the greatest calamity the oil industry of Galicia has ever experienced. How great this disaster proved to be is shown by the fact that since 1910 many new wells have been drilled in other parts of the field, yet the production has continued to steadily fall off, and in consequence of the spreading of the water trouble, so fatal to all oilfields, is still declining. It remains to be seen what results will be obtained from the many new wells located in the

southern part of the field and whether further fall in the production may be stayed.

Water first showed itself in the wells called "Napoleon Doska" and "Annen" in Tustanowice; it spread with great rapidity, and day by day more wells became affected. Within the short period of four months some thirty odd wells had reported water trouble, and within nine months over ninety were watered. At first the percentage of salt water was small, but quickly increased, and within a very short time the percentage of oil to be extracted was so small that it no longer compensated for the cost of production.

Wells within the watered area produce their oil and salt water in emulsion, the higher the percentage of salt water the more reddish the emulsion becomes in colour, and the separating out of the oil presents many difficulties. The following methods of cleaning are adopted in Galicia:—

1. When the oil contains up to 20% of water salt and dirt in suspension, the oil is heated in closed tanks of from 50–100 tons capacity, by means of steam coils for a period of from 5–12 hours, after which it is allowed to settle and cool down. The salt water and dirt are then run off. By this method of cleaning there is a wastage of about 5% of oil, and the cleaned oil still contains from 1–5% of dirt and water.

2. Oil in emulsion containing over 20% of salt water and dirt is cleaned by washing the emulsion with clean water. One ton of water is usually taken per ton of emulsion, live steam is used to agitate by blowing it directly into the liquid near the bottom of the tank. When the emulsion and water have been thoroughly heated and mixed, steam is turned off; the water and dirt being allowed to settle out. Time required for heating and mixing in the above manner is from 5–10 hours or longer, depending on what percentage of salt water and dirt the emulsion contains. This is a very crude and wasteful method and cannot be recommended, the amount of oil lost when drawing off water and dirt is from 5–15%, and sometimes more, dirt and water content in clean oil averages from 1–5%, or even more. The quantity of steam used to heat and mix 40 tons of emulsion plus 40 tons of water is from 1000–2000 lbs. (at 8 atm. pres.).

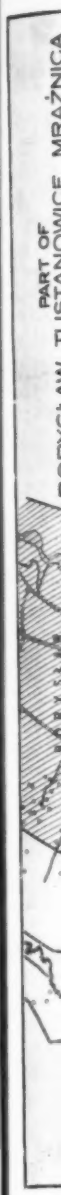
3. Another method to clean the oil is to use caustic soda in the following manner:—30–40 tons of emulsion is thoroughly mixed with an equal quantity of clean water by means of live steam for three hours, when a strong caustic soda solution is sprayed in and the mixing is continued for another five to six hours. The amount of caustic soda required is from 5–15 kilos. per 10 tons of emulsion. The mixture is then left to settle and cool down when the salt water and dirt becomes separated and can be easily let off. It is not generally necessary to repeat the process, but in case it is found that

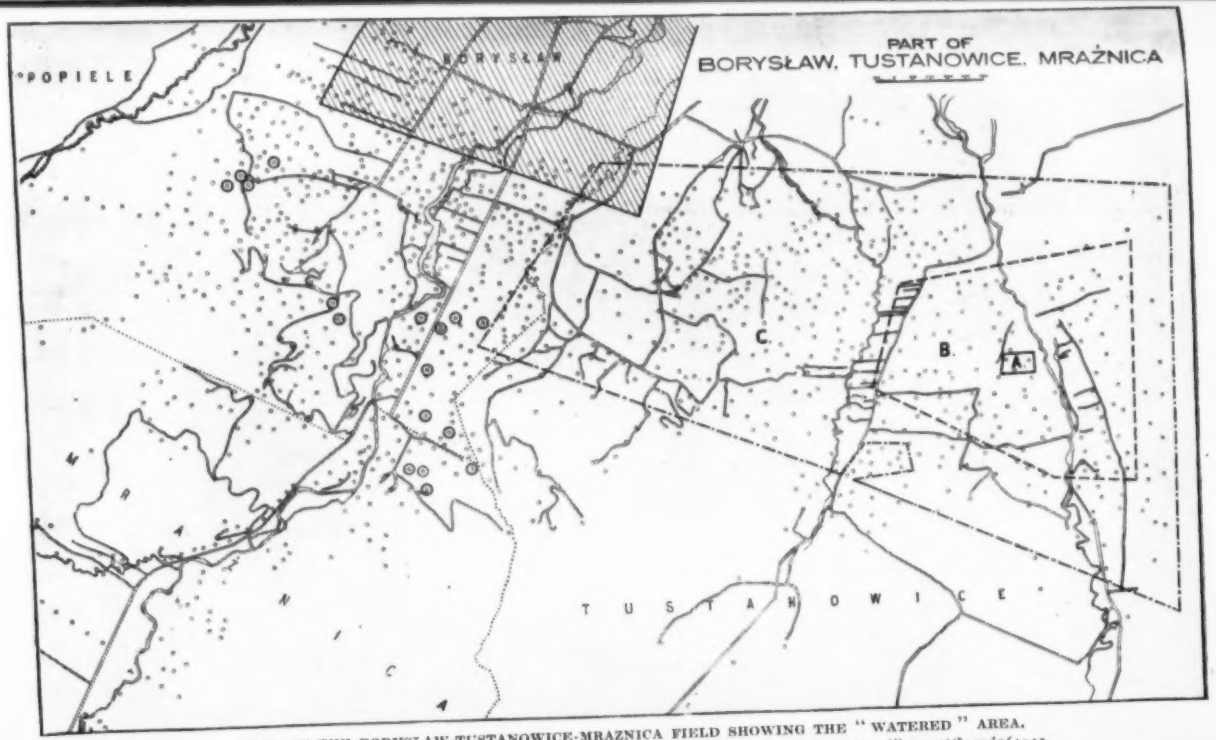
the oil still contains too high a percentage of foreign matter the operation can be repeated, but using only from 3–5 kilos. of caustic soda per 10 tons of oil. This method is a great improvement over 1 and 2, as practically the full percentage of oil contained in the emulsion is recovered, the loss being seldom higher than 1%. The writer has treated large quantities of emulsion containing from 10–20% of oil and after treatment with caustic soda, tests showed a dirt content of from 0.5 to 1%. The amount of steam necessary is about the same as with method 2.

De-emulsification of the oil can also be attained by bricking in a Lancashire or Cornwall boiler in the same manner as though it were intended for steam generating, excepting that the safety valves are so arranged as to come outside the building. Arrangements are made to feed the emulsion into the boiler and a connection is also made from the usual blow-down pipe for letting off water and dirt after cleaning. The method of procedure is as follows:— The emulsion is pumped into the boiler until the gauge glass shows "full," firing is then commenced, slowly at first, until the pressure gauge records 1 atm. when firing is slightly intensified, until 6 atm. are reached. The gradual bringing up of the pressure to 6 atm. takes from 3–5 hours, depending on the size of the boiler used and the amount of emulsion being treated. The emulsion is kept at 6 atm. pressure for 2–3 hours, when firing is stopped. After the boiler has cooled down to about 80° C. the blow-down cock is opened, and the water which has separated itself during heating from the oil, comes away first, this is followed by the mud and finally clean oil begins to run. The latter is let off into separate tanks where it is stored pending piping over. Oil thus recovered contains 3–4% of dirt in suspension, and wastage does not exceed 1–2%.

Although this is an economical improvement on the systems of de-emulsifying previously mentioned, it is an exceedingly dangerous method and its adoption cannot be advised for the following reasons:—When a fresh supply of cold emulsion is run into the boiler and firing is commenced, if very great care is not taken to see that firing is done very slowly until a pressure of 1 atm. has been obtained, and the contents of the boiler are at the same temperature throughout, thus allowing the gas and steam forming on the inside of the plate to circulate freely. Gas and steam under rapid firing are quickly generated and collect along that part of the plate where the greatest heat is concentrated; at this point a pocket of gas and steam is soon formed which cannot rise through the several feet of cold viscous emulsion, with the result that the plate soon becomes red-hot at this part.

An explosion recently happened in an installation of this kind in Boryslaw, resulting in considerable damage and loss of life.

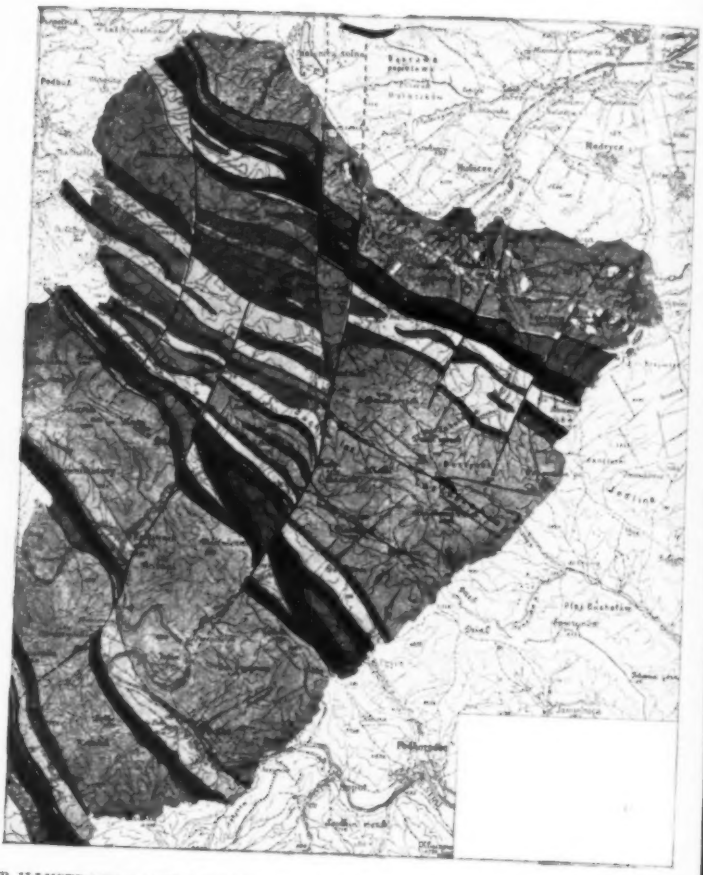




MAP OF THE BORYSLAW-TUSTANOWICE-MRAZNICA FIELD SHOWING THE "WATERED" AREA.

A. Where water was first observed. *B. The "watered" area at the end of 1911.* *C. The "watered" area at the end of 1921.*

O. The wells in which during the last few months water has been reported.



MAP ILLUSTRATING THE GEOLOGICAL STRUCTURE OF THE WEST GALICIAN OILFIELD.

There is another way of de-emulsifying under pressure, which is equally as efficacious as the foregoing, though perhaps a little slower, but all danger is eliminated.

Emulsion is pumped into a Cornwall or Lancashire boiler, which is slowly heated and brought up to a pressure of from 5 to 6 atm. along which a number of small holes have been drilled, is fitted into the boiler about 6 ins. from the bottom, and is connected up to the nearest main steam line. After the charge of emulsion has been pumped in, live steam is admitted into the boiler through the "U" tube until a pressure of 5–6 atm. is obtained; the pressure is then maintained from 2–3 hours, after which the boiler is allowed to cool down as in the previous instance. As there is no brickwork the time of cooling down is much quicker. The cost of cleaning 10 tons of emulsion is a little higher by this method than with direct firing. An alternative to this is the use of direct firing and steam used simultaneously.

There was much diversity of opinion as to the origin of the salt water when it first showed itself in Tustanowice. Many experienced oilmen thought it was top water which had broken through, whilst others came to the conclusion it was the natural sign of exhaustion. This latter theory being shared by the late Dr. Rudolf Zuber of the Lemberg University, who wrote a very interesting article on the subject, which appeared in *Petroleum* in 1912. He stated it was his belief the watering of the field was but the natural result of the exhaustion of the oil—water taking the place of oil in crevices previously richly charged with this mineral, especially if one took into consideration the large amount of oil and gas which had been produced over a comparatively small area.

Dr. Konstanty Tolwinski, Chief of the Boryslaw Geological Station, is of the opinion that the source of the water was in the eocene series. He has written a detailed account of his observations in a pamphlet entitled *Zloza ropy i wode podziemne Boryslawia na tle budowy geologiczny* (the subterranean oil and water charged formations in relation to the geology of Boryslaw), in which he states that certain wells drilled into water-bearing formations, which throughout the field, more or less regularly, underlie the oil-charged sands. The influx of water was for a time held in check by the gas pressure, but when this pressure diminished the water very quickly obtained the upper hand.

The water column rapidly rose to 300 meters in the bore-holes, thus coming into contact with the oil-bearing sands, which it soon penetrated, being assisted by the intensive swabbing of the surrounding wells. The water proved to be inexhaustible; incessant swabbing in many wells, as for instance, "Dereczyce," etc., did not result in the slightest reduction of the water column.

It is an established fact that the eocene series contain much water in some areas, and nearly every well which has been drilled through this series has struck at different depths what is generally known as "solanka" or brine in varying quantities. Some of the wells have met with such immense quantities of water that it has been impossible to even lessen the height at which it stood in the borehole.

During 1911 and 1912 the water spread rapidly; progress made in individual wells can be judged by the fact that a certain well, "Nowina," reporting 4% water and 5% emulsion on the 16th July, 1911, stated that at the end of the same month tests proved 5% water and 25% emulsion, by the 18th August the production of this well contained over 20% of water and 30% emulsion; shortly afterwards it was closed down altogether. Since 1915 the water has made less headway, but still gains ground, and at the present time not only is Tustanowice flooded, but there are wells in the eastern and south-eastern part of Boryslaw producing emulsion. Sometimes oil and salt water not in emulsion is produced, but these cases are rare.

In 1912, owing to the watering of Tustanowice, many old wells in the Boryslaw district which had been abandoned since the critical year of 1908 were re-opened up, some of them being deepened and are still producing small quantities of oil to-day. Even at the present time derricks are being strengthened and work being recommenced on the "Potok" in the anticipation that small but steady productions will be obtained after reconstruction of the wells.

Territories directly adjoining the Boryslaw-Tustanowice oilfield are receiving a great amount of attention from prospectors, at the present time, Mraznica and Hordyscze being mostly in favour; whilst to the west of the Boryslaw field numbers of wells are being drilled on what is known as the Ratoczyn and Opaka territories. The previous illustration shows the proved area of the Boryslaw-Tustanowice and adjoining oilfields; it also shows the south Tustanowice-Mraznica-Horodyscze-Ratoczyn fields, which are so much in favour at the present moment, but whether results will fulfil expectations only the drill and time can prove. About twenty-five years ago, many wells were sunk in Mraznica to a depth varying from 150 to 400 meters; although one or two wells were sunk to over 700 meters, only small but steady productions were obtained. Many of these old wells are still producing small quantities of oil to-day. It is interesting to note the development which has taken place in the Mraznica-Horodyscze fields since the watering of the Tustanowice area. In 1912–13–14 territory was taken up to the south of Boryslaw, and although people in general were somewhat sceptical as to the results to be expected from drilling

so far to the south of the already opened-up producing zone, and many prominent oilmen were not at all favourably inclined towards this district, speculative interest was awakened, and what is generally known as "wildcatting," was undertaken by a few firms. Ground was leased, forests cut out and roads constructed, and here and there a derrick went up. During 1913 the first well in this section of the field came into production with 120 tons per day, from a depth of 1272 meters; this well did not flow, and the oil had to be brought to the surface by means of the swab, there being very little gas. The well has produced 92,000 tons, up to the present day, and is still giving about 5 tons per twenty-four hours with a very small quantity of gas. No sooner had this well been brought into production than there was a general rush to secure leases in this part of the field, prices soared, and persons who had bought large plots for speculative purposes reaped rich harvests. Leases were generally for a period of twenty-five years, and were encumbered with from 20–21% royalty. In 1913 and 1914, derricks went up in all directions, and each company vied with the other to get down to the oil first. In August, 1914, a momentary check was given to these operations, but soon after the Russian Army had retreated, and the Austro-Germans had retaken this territory, work was renewed with increased energy as the value of these oilfields and the need of petroleum to carry on the war was fully realised by the Central Powers, who gave every assistance to prospectors and encouraged them as much as possible to drill and thus to increase the production. Everything in the Government's power was done to advance the industry in every conceivable way. Men necessary for working and managing the wells were freed from military service, and all production was requisitioned and could not be disposed of without special permission from the authorities. Technical materials were rationed out, preference being given to wells nearing production and producing wells.

Drilling in the Mraznica-Horodyscze part of the field is very much more tedious and costly and the wells have to be carried down to much greater depths than in either Boryslaw or Tustanowice. In addition, valuable columns of casings have to be left in to shut off waters, yet in spite of these facts and the greatly increased cost of drilling, without taking into consideration the difficult problem of labour, derricks are being erected and prospectors are pushing more and more to the south in their search for territories not already leased.

Should the most southerly placed wells in the Mraznica field prove to be productive, it will have a width of over 2½ kilos., but it is feared that the oilsands of the Lower Oligocene will lie at such a great depth that it will prove technically impossible to reach them with the drill, or if they are within reach of the drill, the cost of

drilling down under existing methods will prove prohibitive. As will be seen from the accompanying chart, the further to the south one proceeds the deeper one has to drill to the oilsands. For instance the Boryslaw sand was struck in North Tustanowice and Boryslaw at from 800 to 100 meters. In South Boryslaw the same sand is met with at about 1300–50 meters, and the most southerly productive well in Mraznica drilled into this sand at 1570 meters. The distance of this well from the Southern Boryslaw boundary is approximately 600 meters. Wells drilling still further to the south prove that the Boryslaw series dips very deeply.

During 1912 and 1913 several deep drillings were undertaken to the north-east of the Boryslaw field (Popiele and Jasienica) four wells were sunk to depths of 1000–1300 meters, small oilshows were drilled through, but no production in paying quantities was struck. As three out of the four wells had 7-inch casing, no doubt, had the war not intervened, drilling would have been continued, but owing to poor prospects of good oil being struck, it was not considered worth while to continue the drilling of these wells under existing conditions.

Production of the Boryslaw-Tustanowice-Mraznica Oilfield.

From the commencement of 1900 until the end of 1921 the Boryslaw-Tustanowice-Mraznica field has yielded nearly 17,600,000 metric tons of petroleum, exclusive of fuel oil, wastage, etc., which represents by no means an insignificant figure. As will be seen from the following tables giving production figures from 1908 until the end of last year, the highest level was reached in 1909, and from that time onwards the production has steadily decreased. During the very critical period of from 1906–1909 many wells in Boryslaw producing less than 60 tons per day were closed down, as owing to the exceedingly low price of crude, a general rush was made to Tustanowice where productions of from 300–800 tons per day were anticipated. This naturally caused a marked fall-off in the production of Boryslaw, and, in addition to this, the very large producing wells, especially those situated in the Potok district, were beginning to yield lesser quantities than formerly, then the watering of the Tustanowice area in 1911 affected the production to such an extent that, in spite of the extension of the field in all directions, the production never recovered, but steadily declined.

The sudden fall in the figures for 1915, and their subsequent recovery in 1916, is accounted for by the fact that whilst the Russians were in occupation many properties were closed down in consequence of administrative and technical staffs having evacuated when the Austrians withdrew their forces. The Russians destroyed 224 wells in the Tustanowice area during their retreat, and although

After the Austrians had retaken possession of the field those worth re-erecting were quickly put into work, nevertheless, the effect on the production was naturally felt.

PRODUCTION.
Boryslaw-Tustanowice-Mraznica, 1908–1921.

Year.	Metric tons.	Year.	Metric tons.
1908	1,553,180	1915	610,090
1909	1,916,180	1916	849,290
1910	1,612,460	1917	789,220
1911	1,300,710	1918	773,856
1912	1,026,940	1919	696,980
1913	900,160	1920	625,558
1914	738,020	1921	563,566

The Petroleum Industry of Galicya is divided into three mining centres, known as the Drohobycz, Jaslo and Stanislaw districts. There are mining offices in each of these towns which are superintended by competent mining officials who are under the control of and are responsible to the Head Mining Office in Krakau. The Drohobycz district is the largest producing centre, as will be seen from the following figures for 1920. Boryslaw-Tustanowice-Mraznica produced nearly ⅞ths of the total Galician production in 1920.

District.	No. of sub-districts.	Produced 1920.
Drohobycz	20 ..	69·0579
Jaslo	45 ..	4·9326
Stanislaw	5 ..	2·4920
		76·4815

There has been no free market for crude oil since the Austrians retook possession of the oilfields in June, 1915, when, owing to a state of war, the Government controlled the disposal of crude oil as also of the refined products. When the Polish Government assumed control of the oil industry the same regulations remained in force. In the latter part of 1921 crude oil was freed from Government control for disposal inland, and it is anticipated that within a very short time the producer will be allowed to export his oil without interference; it is probable a law will be passed ensuring home refineries being supplied before export needs are met.

The following figures give the highest and lowest prices obtained for Boryslaw crude in the years 1920 and 1921 in Polish marks and £ sterling:—

	Price per ton in P. mks.	£ sterling per ton.	Rate of exchange.
1920—			
Lowest	.. 1800 ..	£3 12 0 ..	500
Highest	.. 7200 ..	9 18 7 ..	725
Average for year	.. .. ..	6 15 9	
1921—			
Lowest	.. 4500 ..	2 5 0 ..	2,000
Highest	.. 15,000 ..	4 14 0 ..	3200
Average for year	.. .. ..	3 2 3	

STATISTICS regarding Crude Oil production, Oil-fuel and Wastage for the year 1921 in the BORYSLAW–TUSTANOWICE–MRAZNICA OILFIELD.

In metric tons.

Month.	Boryslaw.	Tustanowice.	Mraznica.	Total production.
..	236,481	225,383	101,702	563,566

Fuel.	Wastage.	Net production.
49,484	55,839	458,243 in metric tons.

STATISTICAL information regarding crude oil production, fuel oil and wastage for 1918, 1919, 1920, 1921.

Drohobycz District.—Boryslaw-Tustanowice-Mraznica.
(In metric tons.)

	Gross production.	Fuel-oil.	Wastage.	Net production.
1918 ..	773,856	31,140	—	742,716
1919 ..	696,989	36,263	57,544	603,177
1920 ..	625,558	49,543	58,222	517,791
1921 ..	563,566	49,484	55,839	458,243

Note re Wastage.—At a first glance these figures appear to be out of all proportion, nevertheless they are correct and can be explained as follows: The gross production includes dirt and water contained in the oil as it is produced from the well, also the total quantity of oil in emulsion produced, consequently there is a great discrepancy between gross production figures and the amount taken over by the storage companies. In addition the pipe-line and storage losses have to be taken into account.

PRODUCTION OF CRUDE OIL IN THE MINING DISTRICT OF DROHOBYCZ DURING 1921.

Place.	Total production. Metric tons.	Place.	Total production. Metric tons.
Rosochy	27	Wankowa	15,393
Tustanowice	225,383	Paszowa	487
Boryslaw	236,481	Sloboda dubienska ..	360
Mraznica	101,702	Strzelbice	1,462
Mraznica 2 (shallow oil)	1,587	Ustrzyki-Lodyna ..	155
Schodnica	23,711	Rajskie	238
Urycz	11,956	Polana	75
Opaka	1,065	Duba	69
Rypne	7,875	Popiele	83
Ropienka	2,327	Kropiwnik	—

The average production of a well in the Boryslaw-Tustanowice-Mraznica district is calculated to be approximately 4,000 cisterns = a total of 40,000 metric tons, but a good well, as, for instance, the "Zofia" Silva Plana 1, Nafta VI. Kossak, Marya, Liliom wells, etc., often give a much bigger production as the following instances show:—

The well "Zofia" which is the most southernly placed producer came into production in 1918 at 1,571 meters and yielded in—

	Metric tons.
1918	13,880
1919	38,220
1920	35,620
1921	35,000
	122,720

The present production of this well is 92 tons per day and 8 cub. mtrs. of gas per minute.

"Silva Plana" 1 came into production in 1913 and has yielded :—

	Metric tons.
1913	1,200
1914	14,730
1915	19,240
1916	15,410
1917	13,630
1918	11,810
1919	8,510
1920	5,450
1921	3,100
	93,080

TOTAL NUMBER OF METERS DRILLED IN THE THREE SECTIONS OF THE BORYSLAW–TUSTANOWICE–MRAZNICA FIELD.

	Boryslaw.	Tustanowice.	Mraznica.	Total.
1918 ..	13,600 ..	10,291 ..	6,252 ..	30,143
1920 ..	14,772 ..	6,813 ..	9,043 ..	30,626

ACCIDENTS.

ACCIDENTS TO WORKMEN EMPLOYED IN THE PETROLEUM MINING INDUSTRY DURING 1921, IN DROHOBYCZ DISTRICT.

	Cases.
1. Fatal	6
2. Seriously injured	81
3. Lightly injured	77

NATURAL GAS.

The Boryslaw-Tustanowice field has produced in the past huge quantities of gas, but a very small part of this great production was used as fuel for the boiler, the surplus being allowed to waste.

The biggest gas wells gave from 150–200 cub. mtrs. of gas per minute, and wells giving from 40–70 c.m. per min. were of common occurrence. To-day the gas production is very small; there are seven wells producing between 16–32 cub. mtrs. per min., ten wells between 6 and 12, and a large number from ½–3 cub. mtrs. per min.

Throughout the field 237 wells are yielding a total of 540.18 cub. mtrs. per min., which averages 2,390 cub. mtrs. per well per min.

Previous to the laying of the Boryslaw-Drohobycz pipe-line in 1912 for the purpose of supplying the State and other refineries with gas fuel, the surplus after fuelling boilers had little commercial value. To-day, when crude oil commands a high price, gas forms one of the principal assets of a company.

The calorific value of Boryslaw gas is from 10,000 to 11,000 calories = approximately 1 kg. of crude oil; its specific gravity is from 0·65 to 0·75. Following are various analysis of this gas:—

	%	
Methane	84	According to Ing. Wasowski.
Heavy hydrocarbons	12–15	
Oxygen trace	—	
Nitrogen	1	
Methane	86·5–83·1	Gruskiewicz and Hausmann.
Other hydrocarbons	8·7–8·8	
Oxygen	·1–1·7	
Nitrogen	3·8–6·4	

Drohobycz-Boryslaw Gas Lines and Compressor Station.

In 1912 a gas-piping station was built in Tustanowice for piping the gas to Drohobycz. This station contains two 2-stage compressors direct coupled to "compound" steam engines of 450 h.p. each.

Each set is capable of compressing 100 cub. mtrs. of gas per min. at 7 atm. pressure.

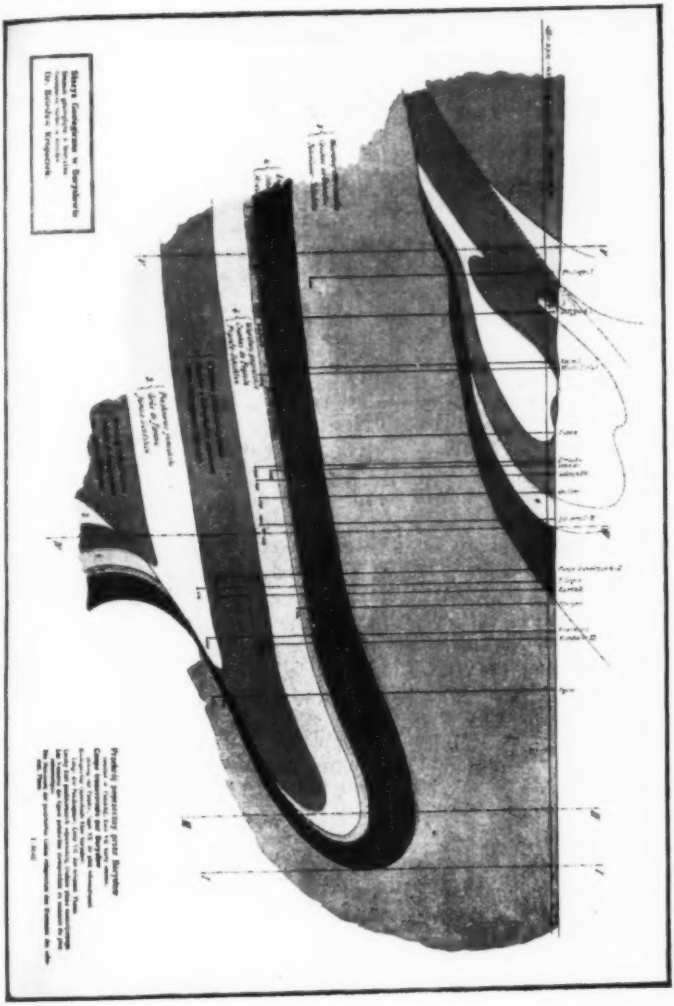
A 9 in. pipe-line connects this station with Drohobycz and 30 cub. mtrs. per min. is being piped at a pressure of 1·5 atm. Length of pipe-line 13 kilometers.

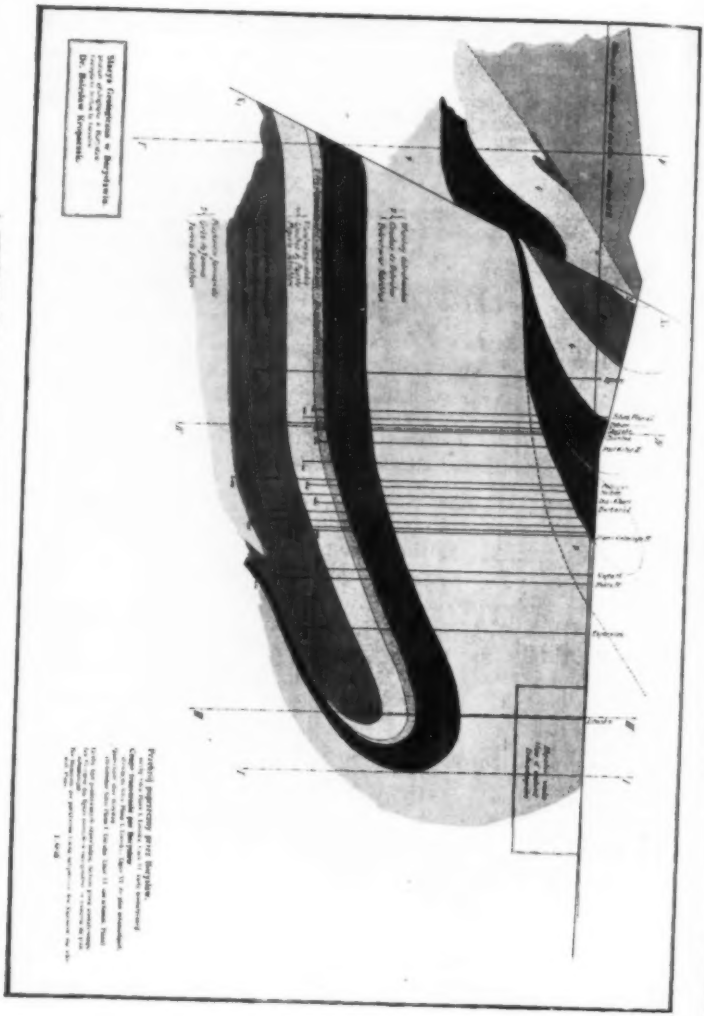
There is a second pipe-line serving the "Galicia" refinery, and gas is piped through this line at 3000mm. water pressure, by means of rotary blowers from the "Galicia" piping-station in Boryslaw.

Gasoline Industry.

At the present moment there are only two factories working producing gasoline, both belonging to the "Gazolina" Co., Ltd. This company has produced the following quantities since 1914:—

	Bitkow. Klg.	Boryslaw. Klg.	Tustanowice. Klg.	Total. Klg.
1914	—	139,600	—	139,600
1915	—	228,200	—	228,200
1916	20,000	408,900	—	428,900
1917	—	330,000	—	330,000
1918	—	303,300	188,600	491,900
1919	—	249,700	199,600	449,300
1920	—	240,400	352,600	593,000
1921	—	363,445	297,913	661,358





A SECTION IN THE BORYSLAW-TUSTANOWICE-SIRAZNICA FIELD.

From 1000 cub. mtrs. of gas 120–150 kilos. of gasoline are extracted, having a specific gravity of 0·66 to 0·67. The amount of gas being treated in Boryslaw-Tustanowice for the extraction of gazoline is 15–20 cub. mtrs. per minute.

The manufacture of gasoline did not make any real progress in this country (Galicia) until 1914, as will be seen from the following :—

1899. Patent for the manufacture of gasoline from natural gas registered by Waclaw Wolski.
1905. Unsuccessful attempt to build a gasoline factory in Humniska Powiat Brzozow, Western Galicia.
1913. Built a gasoline factory in Bitkow which was not a success owing to the low percentage of gasoline in gas from that district.
1914. Gasoline factory working on the compressor system put into work in Boryslaw by Ing. Marjan Wielezynski. This factory is working at the present time.
1918. Gasoline factory put into work by the "Gasolina" Co., Ltd., in Tustanowice working on the compressor system.
1918. Gasoline factory erected by the "Galicia" company in Tustanowice which did not prove a success.
1919. A gasoline factory fitted up on the "Linde" system by the "Natural Gas and Gasoline Co., Ltd.," of Tustanowice. This was not a success on account of the complete freezing up of the whole equipment.

Galician Refineries.

The throughput of each refinery is given as accurately as possible ; it can, however, only be taken as approximate, as the capacity varies according to the products and by-products refined. The refineries also endeavour for private reasons to keep the throughput as secret as possible.

Principal Refineries situated in Galician Poland.

	Throughput capacity. Metric tons.
Vacuum (Dzieditz)	100,000
Schodnica (Dzieditz)	70,000
Polmin (State Refinery, Drohobycz)	300,000
Karpat (Mariampol)	50,000
"Dros" (Trzebina)	95,000
"Dros" (Peczenicyn)	20,000
"Dros" (Drohobycz)	50,000
Limanowa (Limanowa)	100,000
"Galicia" (Drohobycz)	100,000
"Wisniewski" (Drohobycz)	20,000
"Gartenberg" (Jaslo)	60,000
"Krosno" (Krosno)	24,000
"Starwiarski" (Krosno)	30,000
"Skrzynski" (Zagorzany)	15,000
"David Fanto" (Ustrzyki)	40,000

There are 62 small refineries in the Kolomea, Neusandez, Sambor, Sanok, Stanislaw and Drohobycz districts ; some of these have

suffered great damage during the war, and very few are working. Their total throughput capacity did not equal more than 11% of the throughput capacity for the large refineries. They did not produce final products, but chiefly manufactured lubricants of an inferior grade and unrefined paraffin wax.

Several of the small refineries have been sold to foreign investors, especially to French concerns, and in one or two instances it is intended to build up-to-date refineries equipped with candle-making plant, etc., on site of the existing primitive buildings. The reason for this is not quite clear, as it is estimated existing refineries could cope with at least 50% more crude oil, were it available.

Transportation.

There are three classes of roads in Galicia, namely :—

Trunk or military roads ..	These generally run parallel to the railways, are well maintained and are suitable for motor transport.
District roads	These vary according to locality, they are generally suitable for motor transport in good weather. All rivers or streams are bridged.
Field roads..	Possible only for horse transport, but in bad weather they become impassable in some districts. Rivers and streams are not bridged.

Difficulty of transport is one reason why many isolated but good oilfields, situated some distance from the railway or main road, after being opened up, have only been able to work for a short time and have then been compelled to close down, owing to the cost of transporting the crude oil to its destination proving prohibitive.

Many enterprises have been undertaken and good oilfields proved, but no provisions were made at the outset for road construction or, after obtaining production, the laying of a pipe-line, that continuation of development became impossible. This has been especially the case with shallow oil-producing properties, where it is not until a number of wells have been brought in that sufficient production is obtained to compensate for the laying of a pipe-line. When intending to develop property where means of communication are bad, unless means of dealing with production after it has been obtained has been taken into calculation, the scheme, however good it may be as far as developing a property is concerned, cannot but end in failure.

Boryslaw-Tustanowice-Mraznica Field is served by a network of pipe-lines, and the usual practice is for one of the storage

companies to lay a line from their own "taking over" station to the well pumphouse. The oil is taken over either on the well in the prospector's own measuring tanks, or in special tanks of one cistern each equalling 10,000 kilos., at the piping companies' station, taking into consideration temperature, specific gravity and dirt content. The oil is then stored and insured by the storage company.

The storage companies combined can cope with about 1583 tons of crude per hour. There are eleven piping depots with thirty-nine one-cistern measuring tanks, and about four cisterns can be taken over in one measuring tank per hour. Many of the largest producing companies have their own measuring tanks on the property.

On a producing mine the storage capacity is generally from 200–400 tons or more.

No records have been kept of the total length of pipe-lines connecting wells with the piping stations and piping station to the tank farms, or connecting one well or property to another under the management of the same concern. The general sizes of pipe-lines used on the Boryslaw-Tustanowice-Mraznica Field can be taken as follows:—

From well to taking over station	3 in.
From T.O. station to tank	4 in–5 in.

In 1916 the military laid a 4-inch pipe-line, 63 kilometers in length from Drohobycz to Chyrow, for a short time this was used for piping refined products. Since October, 1918, about 19 kilometers of this pipe-line has been used for piping water from the Bystrzyoy River to the State Refinery in Drohobycz. This pipe-line cost kr. 1,078,757, to lay, the Germans contributing nearly four-fifths of this amount.

At the time of the Russian retreat in May, 1915, 631,290 tons of crude oil were stored with the different storage companies; of this amount 330,000 tons were destroyed (according to statistics compiled by Dr. Alfred Kohl for the Polish Congress).

Storage.

In August, 1914, the tank and underground storage for the Boryslaw-Tustanowice-Mraznica field and other adjacent small oilfields had an aggregate holding capacity of 1,430,000 tons. During the retreat of the Russian Army from the Carpathians on the 13th, 14th and 15th May, 1915, steel tanks of about 270,000 tons capacity were set fire to; some of these were completely destroyed and others could have been put into use again after

effecting repairs. None of the damaged tanks have been repaired and only one or two have been dismantled; those left standing are rapidly deteriorating from constant exposure and want of paint and attention.

COMPARISON OF TOTAL STORAGE FOR 1914-1920.

	1914. Tons.	1921. Tons.
Steel reservoirs capacity	920,000 ..	650,000
Earth underground capacity	510,000 ..	400,000
Total	1,430,000 ..	1,050,000

The earth underground storage reservoirs (ambars) are all more or less in need of repair, and will in all probability not be used again on account of the great loss through seepage and evaporation. Most of this earth storage was hastily constructed in 1907–1910 to deal with the huge quantities of oil being produced in the Tustanowice section for which no other provision could be made.

In case of tank shortage, the steel reservoirs used for Mraznica and Schodnica light oils could be used for the heavier grade oil of Boryslaw-Tustanowice-Mraznica, this would increase the tank capacity by about 70,000 tons and brings up the total available tank storage in good condition to 720,000 tons.

Ambars.—Ambars or earth storage reservoirs were built of large dimensions from 50–80 meters long by 40–80 meters wide, depths varying from four to seven meters (inside dimensions). The construction was briefly as follows:—

After the necessary excavation work had been carried out, the bottom and sides were lined with well puddled clay or lepp, this latter being the argillaceous residue after ozokerite has been extracted from Miocene clay by boiling and is especially suitable for this kind of work as it contains practically no sand. Lepp could be obtained in large quantities from the Boryslaw ozokerite mines.

When the lining of the reservoir with puddled clay is completed, it is boarded over. The roof is of wooden construction and is supported by a veritable forest of timbers. After the roof has been covered by boards, impregnated felt is put on and this, in turn, is covered by a thick layer of clay, thus rendering the ambars practically fireproof and forming an excellent protection against climatic influences.

No accurate statistics have apparently been kept showing the percentage of loss due to evaporation and seepage, but from infor-

mation gathered it would appear that losses resulting from these causes were not as great as one would have anticipated. As regards evaporation the fact of the Boryslaw-Tustanowice crude oil containing not more than an average of 5% benzine when piped into these storage reservoirs must not be overlooked.

Ozokerite.

Ozokerite has been mined in Boryslaw for many years. The first authentic record is, however, found amongst the Mining Archives, relating how in 1854 R. Doms discovered rich deposits of this mineral. Whilst digging shafts for crude oil in 1860 ozokerite was encountered in large quantities at from 15–20 meters below the surface in miocene marls. At that time this product, being of no commercial value, was dumped on the fields alongside. When struck, it was often under such strong gas and earth pressure that the sinking of hand-dug shafts for the exploitation of petroleum had frequently to be abandoned.

It was not long before the commercial qualities of this product were recognised, and within a comparatively short space of time scores of proprietors were working hundreds of hand-dug shafts, and by the year 1900 over 15,000 men were employed in the 1200 ozokerite shafts then being worked.

As is the case with the oil industry, it will be noticed from the statistics given that the production of ozokerite is decreasing year by year. In 1885 the highest production was recorded, reaching 10,400 tons; the present yearly output is about 250–280 tons.

In the early days of this industry the ozokerite was mined by means of the pick from rich veins. The wax contained in the material excavated during the exploitation of these veins was formerly not considered worth while extracting, but since then has yielded from 2–8% of ozokerite.

The ozokerite mines are situated in the northern part of Boryslaw, and consist of from 180–200 acres of more or less productive zone. The hard white wax, generally known as "Marmorwax" or "Boryslawit," and which was found in rich deposits from 20–100 meters beneath the surface and in lesser quantities from 100–200 meters, is pretty well exhausted, and now practically only the yellowish-brown-black grade is mined. Of the two grades of wax sold by the Ozokerite Mining Co. one has a melting point of from 66–67° C., and the other from 70–71° C. It is used principally for the manufacture of wax candles for churches, medicinal vaseline, insulation for electric cables, for waterproofing, etc. It is also known as "Ceresine."

Following were the results of dry distillation carried out by the well-known authority, Josef Merz:—

1. Olive green coloured wax. Sp.g. 0·923. M.p. 60·5° C.

Light oils, boiling point up to 150°	6·25%
Heavy oils with paraffin B.P. 150°–300° ..	35·1%
Paraffin B.P. above 300°	49·73%
Residue and loss	8·92%

2. Dark yellow coloured wax. Sp.g. 0·93.

Benzine	4·32%
Petroleum	25·65%
Lubricating oils	7·61%
Paraffin	56·64%
Coke	2·85%
Loss	2·93%

3. Dark brown coloured wax. Sp.g. 0·93.

Benzine	3·50%
Petroleum	27·83%
Lubricating oils	6·95%
Paraffin	52·27%
Coke	4·63%
Loss	4·82%

During the war the wax mines were only partly worked, the production equalling about one-third of that obtained prior to 1914. At the present time operations are being extended and it is anticipated the output will be higher.

The production for 1918 was 357·5 tons.
" " 1919 was 326·1 "
" " 1920 was 286·2 "
" " 1921 was 304·0 "

The number of workmen employed in this industry equals 430.

There is another ozokerite deposit being worked, *i.e.*, Dzwiniacz, in Eastern Galicia. This mine produced 126 tons during 1921. Number of workmen employed, 75.

Six other ozokerite fields are known to exist in Galicia, mostly all situated in the eastern part of the province. This mineral is found in the miocene and upper oligocene formations.

Legislation.

In November, 1918, upon the Polish Government taking over that part of Galicia which had previously constituted part of the late Austrian Empire, it was decided that all laws formerly in force should be continued, pending modification or supplementing from time to time such laws as necessity might demand; consequently the transitory period during which one State was being

absorbed by another caused much less trouble and confusion than might otherwise have been anticipated.

Foreign companies operating in Galicia were compelled under the Austrian Law Companies Acts to form an Austrian Holding Company—Gesellschaft mit beschraenkter Haftung; in Polish—Spolka z ograniczcna poreka. There were no restrictions, however, regarding the nationality of either shareholders or managers or any person holding power of attorney. Laws recently passed by the new Polish Government relation to the forming of limited liability companies are somewhat more stringent than formerly, and more difficulty is experienced in registering rights of ownership or freehold property in the names of persons not being "nationals" than used to be the case, but the difficulties are not such that they cannot be overcome.

All holdings are recorded in a so-called "ground register" in which are also entered all mortgages or other encumbrances; no difficulty is found in ascertaining the area of any particular holding or the position with regard to mortgages, entailed property, etc. To ensure indisputable right of ownership it is absolutely essential to be entered in the ground register. Catastral maps are made of every district and lodged in the Court, where they are open to public inspection at any time. Copies can also be obtained of these maps from the principal booksellers.

Holdings in any district are clearly shown on these maps, and the numbers of the plots enumerated thereon correspond with the numbers entered in the ground register; therefore, if proper precaution is taken, no difficulty should be experienced in getting titles in order under this admirable manner of property registration.

The Mining laws governing the petroleum industry of Galicia are not complicated or irksome, so long as one endeavours to comply with the rules regarding distance of one well from another, from buildings with chimneys, from public thoroughfares, from waterways, boundaries, buildings containing dangerous machinery (motors, etc.), etc., etc. One cannot but admit that the Mining laws are fairly liberal and adapt themselves for still further improvement to keep them up-to-date, consequently they are not prohibitive in relating to free competition of international capital.

Some of the Principal Laws to be observed issued by the Mining Office.

1. *According to an old law* issued by the Mining Office in 1904, the borehole must be located at least 15 meters from the boundary; should the total width of the property, however, be less than

30 meters, then the borehole has to be placed in the centre, but the distance to the boundary must not be less than 10 meters.

2. *According to new law* passed on the 22nd March, 1908, wells must be located at least 30 meters from the boundary and at least 60 meters from a neighbouring well.

NOTE.—Some leases taken up before the issuing of the new law in 1908 come under the old regulations, which apply until expiration of these leases. All contracts entered into after the law was passed in 1908 must conform to the new conditions. An exception to these rules can only be granted by the head Mining Office in Krakau.

Under the old law boreholes may be located 30 meters from dwelling-houses, boiler houses, public roads; under the new law they must be 40 meters distant.

Under the old law the borehole must be at least 40 meters from public buildings, churches and cemeteries, and under the new law 60 meters.

Under the old law boreholes must be 70 meters from ozokerite shafts and under the new law 100 meters.

Under the new law boreholes must be at least 30 meters from any public property; as waterways constitute public property, they must be 30 meters from any river or stream.

Oil reservoirs of over 200 tons capacity must be at least 40 meters from the borehole or public highway.

Oil reservoirs of lesser capacity 20 meters.

Oil-fuel reservoirs must be at least 10 meters from boiler house.

The new Mining law issued in 1908 overcomes to a great extent the evil of offset drilling, therefore saving much unnecessary expense and waste. Prospectors are recognising the bad policy of placing wells too closely together, and the average distance of one well from another is 80 meters.

NOTE.—Owing to lack of space in the Journal, this paper had to be considerably curtailed. The original MSS. has been filed in the Library of the Institute for reference purposes. A bibliography will be issued in the next number of the Journal.

DISCUSSION.

The Chairman, in opening the discussion, said that everyone who had used a reference book like Sir Boverton Redwood's *Petroleum* must realise the great value of obtaining summary descriptions of special oilfields by authorities who had spent a considerable time in the district, and were therefore personally acquainted with every phase of the petroleum industry. He was quite sure the members would wish to express to the author their very sincere thanks for the complete summary he had given of the oil industry of Galicia. The paper lost in value only because it

TYPICAL WINTER VIEW IN THE BORYSLAW FIELD.

COLLECTORS SKIMMING OIL FROM OIL-TRAP.

was so complete that it hardly lent itself to discussion. On the other hand, it covered every phase of the Galician oil industry, including the distribution of the oil, the geological features of the fields, the conditions of exploitation, the transport systems, the local refinery practice, the statistics of production and even the legislation governing the holdings. There were Members present who possessed local knowledge of Galicia and knew fields similar in character, who would desire to contribute to the discussion, or to ask for further information on special points. So far as the geology was concerned, the author had drawn attention to the subject only from the point of view of the general geological formations, supplementing his summary by a brief reference to the peculiar structures as illustrated by the sections shown on the lantern slides. The field was in general geological nature similar to the series of south-eastern fields that formed apparently bays of what was now the Mediterranean shrunken relic of the great ocean that stretched across Eurasia, throughout the Cretaceous and up to about Middle Tertiary times. Whether those were separate bays originally, or whether the fields had since been isolated by folding was a matter that was to a certain extent disputed, the probability being that the fields were outlined as original bays, whilst the structures had since been accentuated by subsequent folding. It would be seen from the sections how complicated were the structures that had developed in Galicia. The most interesting section of the paper, and probably, from the point of view of the industry, the most important for discussion, was that which dealt with the way in which water had invaded the Boryslaw-Tustanowice-Mraznica field. When water invaded a field and spread like an epidemic disease, it gave oil technologists in all parts of the world something to think seriously about, and the oil investor something to be nervous about. He desired to obtain from the author further local information on certain points. For instance, he would like to know whether any attempt had been made by legislative enactment to restrict the system of drilling, or whether any provision had been laid down with regard to the methods adopted for shutting off water during the process of drilling. He saw quite well how difficult it was for the best driller to avoid accidents. In view of the author's remarks in regard to the number of crushed well casings and the number of wells that were lost through drilling difficulties in fields that were geologically so complicated, one realised how almost impossible it would be to draft any regulations of more than local application. He desired, however, to know whether the Government or any local authorities had attempted it, and, what was far more important, whether any of the companies had been able to draw up regulations calculated to prevent the spread of the appalling disease of water invasion.

Mr. Halse said he would like to ask a question with regard to the gas produced from the wells in Galicia. He had noticed in Rumania that thousands and thousands of cubic feet of gas were going to waste. It was, however, very easy to run pumping from a very small gas production by introducing a tube perhaps 200 or 300 feet down the well. A great cry in Rumania at the present time was for more electricity with which to pump the wells, but why should not the gas be used? The cost of a gas engine from Germany or Czecho-Slovakia was very little more than the cost of an electric motor, but the power was obtained free. It would be interesting to know how far advantage had been taken of that free power on the Galician oil fields.

Mr. C. Dabell enquired whether the author really meant that the Boryslaw-Tustanowice-Mraznica field was absolutely flooded at the present moment, or whether he anticipated that it would be completely flooded in the near future. In view of that danger and the fact that it took twelve months to drill a well 500 metres deep he would like to know whether there was anything encouraging at all about the whole of that field at the present moment. Were there any parts so far free from the danger of flooding? He would also like to know the method adopted by the pipe line companies for testing the oil in order to determine the amount of dirt and water that it contained.

Prof. Madgwick thought the question of the invasion of the Galician oil fields by water was the most interesting topic dealt with in the paper. One of the great difficulties that most oil technologists who had not actually lived in Galicia were faced with was the continually changing published views on the geology of the fields. The Zeppelin-shaped fold shown in the sections that had been exhibited were new to most of the Members. Formerly, when the question of shutting off water had first to be considered, it was thought that this invasion was much facilitated by faults. All the valleys shown on the map were considered to be dip faults, and when water first made its appearance it was generally thought that it was travelling along channels that were opened up by those faults, both strike and dip, and that some of the streams which followed the dip faults were contributing to the supply. He believed efforts were made in the early days to cement off some of those streams, and many engineers built great hopes on those efforts, which were afterwards found to be ill-founded. He would like to know what the author's opinion on that kind of work was, and whether if it were carried out more systematically there would be less invasion of the fields by water.

Dr. J. A. L. Henderson said it was very interesting to hear from the author, in regard to the utilisation of natural gas, that the processes for the extraction of the gasoline from natural gas

were now being actively exploited. With regard to the figures given for the productivity of the gas wells, he would like to know whether they related to estimates of the initial production of gas wells or to the actual production as measured over a period, say, of each year.

Mr. Rappoport asked for further information with regard to the cost of drilling on the Galician fields. The question was probably difficult to answer in view of the fluctuating rate of exchange, but a few months ago the cost of drilling, he understood, was roughly about £7 per metre, which worked out at about £10,000 for each well. In view of the fact that it took four or five years to drill some of the wells he would like to know if any attempt had been made on the Galician fields to alter the system of drilling. He understood that the old Canadian rig was still in use. Had the rotary system been introduced or had any proposal been made to do so? He imagined that inasmuch as it took twelve months to drill to a depth of 500 metres by the present system that the adoption of the rotary system would reduce the cost of drilling and perhaps prolong the life of the field, which evidently was in great danger, apart from the question of water. Having recently visited the fields, he had come to the conclusion that the time had arrived when the system of drilling adopted should be altered. Figures of the selling price of crude oil had been given, and it would be equally interesting if the author could furnish particulars of the cost of production. He understood that some months ago the cost of production was anything from 10 marks to 20 marks Polish per kilo. Possibly some standard figure had been arrived at at the present time. The question of fuel consumption was also of importance, particularly in a field which appeared to be rather in the dying stage from the remarks the author made. He believed some statistics existed showing that in some cases as much as 50 per cent. of the gross production was being used for fuel. He would like to know if any means had been adopted to overcome that serious loss. Had the electric power, which he believed was being installed, been yet applied?

Mr. E. A. Evans asked the author to state in his reply the range of finished products obtained from the refineries and the method of refining adopted.

The Chairman, in referring to Mr. Dabell's remarks, said the paper as briefly summarised gave the casual looker-on the feeling that the field had completely been destroyed, or very nearly so, and that the sooner an investor sold out the better. He would like to be quite sure, however, that the Members did not leave the meeting with a picture of the Galician oil field in their minds which was out of perspective. They would like to know to what extent damage had been already done, and to what extent the

future of the field was in danger by the inflow of water. A good deal of preventable loss must have occurred, and if the Institution could help the oil companies to tackle the difficulties that arose through the inflow of water into wells it would have justified its existence.

Mr. Albert Millar, in reply, said that various drilling systems had been tried on the Galician oilfields, among others, the "Fauck and Raky" waterflush systems, but both these had been more or less condemned, as prospectors drilling on plots directly adjoining those being exploited by the flush system found that the flush water entered their wells, also that the oil sands became partially or totally waterlogged.

Legislation was enacted against those systems, and they were only to be used for drilling down to within a certain distance of the oil sands, and then a change over was made to the Canadian Pole system. Up to 1912 very little was done to ensure the effectual shutting off of water. Nearly all drilling was given out in contract and very few companies worked on their own account, consequently drilling went on in a more or less happy-go-lucky way, the contractor's main aim being to get down to the stipulated depth or oil sand with as little trouble and as quickly as possible. As soon as this end was achieved the well was handed over, and it mattered very little to the contractor whether the water was shut off or not. Old casing was often used, and it was a general practice to have the greater part of the same perforated.

When water had shown itself in 20 or 30 wells, committees of producers (chiefly technologists) were formed, and after much discussion the Mining Office made it compulsory that all wells showing water were to be continuously swabbed, whether the management were in agreement with this procedure or not. The result did not give the desired effect; on the contrary, there were many instances of wells producing a small quantity of water with the oil; these would probably have continued producing in this manner for a considerable time, but being compelled to swab intensively, the natural end was only hastened. The result of the continual swabbing was that many wells drew the water in and thus helped to extend the watered area. The first wells to become watered were deeper than many of those surrounding them, the water column rose in the deeper wells until it penetrated the oil sands from which the shallower wells derived their production.

One must recollect that in those days a production of from 100–150 tons per day was not considered large, and many prospectors, in the hope of obtaining a larger production, drilled through the oil sands (Lower Oligocene) sometimes 50–100 metres deeper, and there seems little doubt that some of these wells let in water

from the Upper Eocene which in parts of the field contain large quantities of water.

During later years steps have been taken to eliminate as far as possible gas wastage, and to utilise all that produced as fuel; this is due to the fall off in the oil production and its greatly increased value. Previously it was not at all unusual to strike a gas production of from 100–300 cubic metres per minute under great pressure, the remainder after fueling boilers was allowed to blow to waste. In a number of cases powerful pumps were used to force quantities of water under high pressure down the borehole to drive back the gas and waterlog the sand, so that drilling could be continued. Sometimes the well was left until the gas pressure had fallen off, which in some instances took several months.

The present gas production throughout the whole district is very small, and generally under low pressure, although there are a few exceptional cases. The majority of the wells produce from one-half to three cubic metres of gas per minute, which is sucked from the wells by means of rotary exhausters.

Practically the whole of Tustanowice is watered, also the greater part of Wolanka and eastern Boryslaw, part of the State lands is watered, and recently water has made its appearance in the Horodyscze district, and to the west of the Boryslaw Herrngasse. During the last six months a number of wells in the northern part of the Mraznica valley have produced their oil in emulsion, whilst others are giving clean oil. About two-thirds of the whole up to the present proven field is watered, the only part of the field producing clean oil is south and west Mraznica, and part of west Boryslaw and Horodyscze. Unless the south Tustanowice and Mraznica field now being extensively developed proves to be oil-bearing in such quantities as to compensate for the cost of deep drilling, the production will continue to fall off. All energy is being concentrated in these two districts and some of the wells are down to over 1000 metres.

The steady decline in the production and the extension of the watered area caused many far-sighted prospectors to dispose of their interests in the Tustanowice-Boryslaw districts immediately after the war, and no doubt there are many interested in this part of the field to-day who would sooner be somewhere else.

Legislation exists at the present time for the protection of the surrounding properties, with the object of preventing the water spreading. It is now compulsory that all casing must be left in. Had these precautionary measures been adopted twelve or fifteen years ago, no doubt the field would have been protected to a certain extent, but it is too late to take preventative steps after the water has already gained the upper hand and the oil and gas pressures

are very low. Previously every producer came in as a flowing well; at the present time flowing wells are very exceptional.

With regard to the taking over of oil by the storage companies from the producers, 15° C. is the standard temperature on which all calculations are based. Crude oil containing an admixture of more than 5 per cent. dirt and water is not accepted and is pumped back again into the producer's tanks. For determining the percentage of dirt and water content in the oil, the centrifugal method is adopted, a mixture of 50 per cent. crude oil and 50 per cent. benzine being used for testing purposes. The temperature of the oil and its specific gravity in the measuring tanks is also taken.

Water had not been properly shut off in the Tustanowice district. When drilling in Tustanowice it was considered that if the casing was stood in the Miocene salt clays, below the water bearing gravels, the well was sufficiently protected against influx of surface water. In all probability this water found a way down behind the casings, especially as in some parts of the Tustanowice field the Miocene clays contain a great deal of salt, and a number of beds of rock salt were drilled through. Pockets of salt water were often met with whilst drilling through the Miocene and "Dobrotower" formations, but, owing to the boreholes always being kept full of water during drilling operations, no records as to the quantity of water met with were kept.

After a number of wells had become watered an effort was made to cement or plug them, but without success.

Gas production figures given in cubic metres were not the flush productions at the very beginning, but after the wells had settled down, but as time went on the gas naturally decreased.

In answer to Mr. Rappoport, who suggested that £7 per metre was the cost of drilling, that was the figure some time ago—in fact, a pre-war figure for drilling a well to about 1250 metres, including rig, boilers, winch, etc., and the time necessary to get down was from 14–18 months in the northern and central Tustanowice and Boryslaw districts. At the present time the cost of drilling a well in south Tustanowice, Horodyscze and Mraznica districts to a depth of about 1400 metres is about half a milliard Polish marks, or approximately £30,000, and the time taken in from 2½–4 years, depending on location.

As the present cost of drilling with the Canadian system in this field is exceedingly high, several firms are considering the advisability of giving the "rotary" another trial, whilst others favour cable drilling. It may be mentioned that several years ago three wells were commenced and drilled to varying depths with the rotary rig and tools, but did not at that time prove a success; possibly the American drillers were at fault and not the system. There is no doubt that whatever system is adopted, whether

"rotary" or "cable," certain changes will have to be made to suit local conditions and an improved type of casing will have to be introduced, as that at present in use is too light and of too small a diameter. One thing is certain, whatever drilling method is adopted slower progress than that at present being made would hardly be possible, and quicker progress combined with lessened drilling costs can be anticipated.

The figures quoted relating to the cost of production, 10–20 Polish mark per kilo, were in some cases too low. For swabbing a well 1500 metres deep, giving a production of from 5–8 tons per day (rate of swabbing, five to six trips per hour), about 3000 kilos. of oil is required as fuel for the boilers (individual wells), so that in order to produce from 5–8 tons it is necessary to burn approximately three tons. The estimated cost of producing oil at the present time is as follows:—

Cost of producing	5	tons	daily,	approximately		30-34	Polish	marks per kilo.
"	"	8	"	"	"	22-26	"	"
"	"	10	"	"	"	20	"	"
"	"	20	"	"	"	13-15	"	"

Several firms intend using electric power for swabbing purposes, and in some instances also for drilling, but the power stations for supplying the current are not yet completed. It is anticipated that the installation belonging to the Premier Company will be working during the present summer, but that in course of erection belonging to the "Galicia" Company not until a later date.

Before the war a large proportion of the crude oil was just topped for fuel, the Austrian Government taking practically the whole of it for the Austrian Navy and the railways. At the present time the production is so small and refined products in such demand that the oil is refined right through and the railways use coal fuel. Following is a list of the refined products produced by the Galician refineries:—

PHYSICAL PROPERTIES OF PETROLEUM PRODUCTS.

Product.	Specific gravity at 15° C.	Visc. 20° C.	Visc. 50° C.	Flashpoint. ° C.	Fire-point. ° C.	Setting point. ° C.	Melting point. ° C.	Remarks.
Benzine	0·700–0·720							
„	0·730–0·740							
„	0·740–0·750							
„	0·750–0·760							
„	0·760–0·770							
„	0·770–0·780							
White Spirit ..	0·780–0·790			25·30° C. Abel Pensky				
Kerosene	0·810–0·820			ca 30° C. „				Colour—waterwhite. Stammer 150–200.
Gas oil	0·860–0·880	1·5–2·0		75–90°→		lower than /5° C.		
Lubricants No. 9	880/85	2·5/3		130/140	165			
„ „ 10	885/95	3·0/4		150/160	185			
„ „ 11	890/900	5·0/6		155/165	190			
„ „ 12	895/905	7·0/10		170/180	205			
„ „ 13	905/915		3/4	180/195	215			
„ „ 14	910/20		4/5	195/205	230			
„ „ 15	915/22		5/6	200/210	235			
„ „ 16	915/25		6/7	200/215	240			
„ „ 17	920/30		7/8	215/225	250			
Cylinder oil→ ..	950/965		23/25	230/245	270			Asphalt content 0·5%
Refined wax ..						50/52		
„ „ ..						52/54		
„ „ ..						54/56		
Asphalt "B" ..							ca 130° C.	

INSTITUTION OF PETROLEUM TECHNOLOGISTS.

The Sixty-fourth Meeting of the Institution of Petroleum Technologists was held at the House of the Royal Society of Arts on Tuesday evening, May 9th, 1922, PROF. J. S. S. BRAME, President, occupying the Chair.

The following Members of Council were present:—Mr. Herbert Barringer, Mr. E. H. Cunningham Craig, Mr. Arthur W. Eastlake, Mr. James Kewley, Mr. T. C. Palmer, Dr. F. Mollwo Perkin, and Professor W. W. Watts.

The following paper was read:—

Kukkersite, the Oilshale of Esthonia.

By E. H. CUNNINGHAM CRAIG, B.A., F.R.S.E., F.G.S.

IT is perhaps unfortunate that a specific name "Kukkersite," derived from Kukkers, one of the localities where the deposit was first exploited, has been given to Esthonian oilshale, for it suggests that it is a new and different mineral that has been discovered on the Gulf of Finland. Oilshale varies greatly in different parts of the world, but there are some essential characteristics which all oilshales must possess and all these are present in the so-called Kukkersite.

The special interest, which has made it seem desirable that a brief account of the Esthonian oilshale should be put before this Institution, is in the facts that it is the oldest oilshale in the world that is being worked, that it is the richest oilshale known, and that it occurs under such extraordinarily simple conditions that by a study of it we may glean much very definite information about the origin of oilshale. It is hardly necessary to state that in speaking of the richest oilshale torbanites are necessarily excluded, and thus the famous deposits of New South Wales, South Africa, Nova Scotia, France, etc., sometimes popularly but erroneously spoken of as oilshales, do not come within the subject under consideration.

The new Republic of Esthonia, a country approximately the size of Great Britain, forms the Southern shore of the Gulf of Finland, from near Narva to the Gulf of Riga, and includes the islands of Oesel and Dago. It marches on the east with Russia, and on the south and west with Latvia.

There are no mountains, the whole country consisting of low-lying plateaux very gently undulating except near the coast, where there is a more or less rapid drop of some 200 feet to sea-level.

Forests cover large areas, and peat-mosses are also extensive, so surface evidence is decidedly scarce, except in the broken ground near the coast and along river valleys.

Formations.

The strata exposed are Cambrian, Silurian (Lower and Upper), and Devonian, but we are not concerned with the latter, which occupies the southern part of Esthonia.

The Cambrian is only exposed along the northern coast and along river valleys. Practically the full thickness has been proved by borings, and a typical section is as follows :—

Dictyonema shale	3
Glauconitic sandstone	11
Dictyonema shale	30
Sandstone	83
Clay (variegated)	150
Conglomerate and sandstone	340
	617 ft.

Archæan granite.

The series lies unconformably upon Archæan granitoid rocks. The sandstone is white, grey, or pale brown, and is quite loosely compacted as a rule, although there are harder slightly calcareous bands ; much of it is beautifully even-grained free-stone, so soft that it can be crumbled in the hand.

Fossils, especially vegetable fossils, are absent or very rare. The clay is pale grey or greenish grey mottled with red or purple ; it is used in cement manufacture and closely resembles many Tertiary clays, *e.g.*, from the Middle or Upper Tertiaries of Trinidad.

The Dictyonema shale is a dark and well compacted shale, containing some 10 per cent. of volatile matter. It often occurs in very thin bands associated with the sandstone. The Glauconitic sandstone is a fine-grained bed, well laminated but calling for little comment.

The lower part of the series has only been proved by borings. Above the Upper band of Dictyonema shale comes a pale littoral limestone, which passes conformably upwards into the Lower Silurian, a limestone of precisely the same nature.

The line between Cambrian and Lower Silurian is drawn on palæontological grounds. The limestone is compact, white or grey, and well-bedded ; it is obviously a littoral deposit, formed along a coast practically free from muddy sediment, and its thin-bedded nature indicates that the deposit was formed slowly.

A few yards above the base of the Lower Silurian limestone comes the oilshale, which is interbedded with limestone and overlain by exactly similar beds. It occurs in several beds which vary in thickness in different localities, but attain a total maximum thickness in places of over 8 feet. Thin and often lenticular beds

of limestone of from 2 inches to 1 foot in thickness separate the seams of shale; some specimens of such limestone contain as much as ten per cent. of bituminous matter. The thickness of limestone overlying the shale beds is considerable. The Upper Silurian and Devonian strata which succeed conformably are of no special interest.

Thin surface deposits of boulder-clay or sand and gravel (raised beaches) occupy a large part of the surface and conceal solid evidence, and during glaciation some remarkable but quite superficial and local disturbance of beds has been caused by the ice sheet that overrode the area.

Geological Structure.

The Geological Structure is striking on account of its sheer simplicity. The strata have never been disturbed since their formation, except for the gentle movement of elevation that has brought them to their present position.

A dip of 1 in 250 towards the south has been proved by levelling in some localities, but the original angle of deposition of these littoral deposits was probably as great. In consequence of this low dip, outcrops are very broad and sinuous on the plateau where the shale and limestone appear. It is by reason of this undisturbed position of the strata that we find Cambrian and Silurian rocks so little affected by their age and resembling Tertiaries in hardness and state of mineralisation; possibly in no other part of the world but in the plains of Russia, Esthonia, etc., are such conditions realised among strata of such early origin.

The Oilshale.

The shale itself is worthy of careful description. It is a fine-grained deposit varying from a warm grey to an olive green in colour when fresh, but weathering a bright reddish brown. It has a sandy appearance and fracture which is quite illusory, as microscopic examination shows that there is not a grain of sand in it. It is crowded with fossil remains, chiefly in small fragments, but on bedding planes several species may be recognised, however imperfect, chiefly trilobites and brachiopods. The fauna is sufficient to enable the horizon to be identified with accuracy.

Under the microscope the matrix appears to be very homogeneous and very finely granular, and all fully and evenly impregnated with a bright yellow kerogen. The fragments of fossils are not impregnated.

Somewhat obscure flocculent red masses are identified as particles rich in ferrichydroxide in the weathered portions, and suggest that there has been some precipitation or concentration of iron

compounds in a flocculent colloidal state. The specific gravity of the shale varies between 1·2 and 1·4, but is naturally affected by the quantity of fossil fragments (calcite) present. As compared with other oilshales the fresh yellow colour of the impregnation is remarkable in so old a rock. It is much fresher and apparently less inspissated than the brown kerogen of the Scottish shales or the brilliant burnt sienna coloured kerogen of the New Brunswick shales. In fact the bright colour is most nearly paralleled by that of the richest shales of Colorado.

It is no doubt the undisturbed state of the strata and their being enclosed in fine-grained limestones that has enabled this kerogen to retain its freshness for such an enormous interval of time. There is a great deal of sandy-looking debris or "fines" formed in digging the shale; but, as stated above, this is due to a finely-granular structure, and not to the presence of any sandy material.

Chemical analyses of the inorganic contents of the shale are very interesting. Many analyses have been made, but they show great variations, due almost entirely to the varying quantities of carbonate of lime (fossil fragments) contained. It is obvious that to get an average sample a large bulk of the material must be ground fine and quartered, while to obtain any reliable data as to the composition of the matrix—which contains the kerogen—a specimen as free as possible from fossil fragments should be selected.

From a series of analyses made in the Central Laboratory of the Esthonian Republic, the composition of the mineral matter is given as follows :—

Silica	32·74 or less.
Alumina	15·76 or less.
Iron oxide	1·68 or less.
Lime (or calcite)	49·64 or more.
	99·82

This is a very high percentage of lime, almost all of which may be put down as fossil debris. Other analyses of dried material give Magnesium and Sodium and Potassium, taken together, 0·4 per cent., and water, 1·2 per cent.

It is obvious from these data that, eliminating the lime as extraneous, the matrix has the composition of a fuller's earth, the most absorbent of argillaceous deposits. Samples tested for moisture gave results as follows :—

The opened upper bed	29·6–33·7
Unopened upper bed	23·2
Middle bed	11·0–17·6
Lower bed	14·6

After being dried at ordinary temperatures moisture percentages were as follows :—

	After a fortnight.	After 6 weeks.
Opened upper bed ..	7·0–8·0	5·55–6·84
Unopened upper bed ..	5·0	3·76
Middle bed	3·6–4·6	2·40–3·78
Lower bed	3·0	2·34

From this it appears that water is absorbed readily by the deposit when exposed, but the bulk of it is easily removed by drying, facts which confirm the chemical data as to the deposit being even with its organic content, still highly absorbent. This explains at once the richness of the oilshale, and gives a clear idea as to how the original deposit was formed. It was obviously a slowly-formed deposit accumulated on a shallow shore line almost entirely free from muddy sediment, only the finest argillaceous material, washed out and naturally vanned or separated by wave and current action, going to form the matrix. The comminuted shell fragments, which are included in such quantity, prove the slow accumulation and the action of waves and currents.

The association and alternation with fine-grained littoral limestones is confirmatory evidence. In this connection there is a distinct resemblance, so far as conditions of deposition are concerned, with the oilshales of Dorsetshire and Norfolk, except that in these cases the environment was argillaceous rather than calcareous, and the resulting shales muddy, with occasional sand grains.

In many respects the Esthonian oilshale presents similarities to the fuller's earth beds associated with the Inferior Oolite in the West of England.

When we come to a consideration of the organic content of the deposit we are at once confronted with a difficulty. Many analyses of the shale have been made to determine the percentages of volatile matter, ash, etc., but they show extraordinary variations. This is probably chiefly due to the methods that have been employed and the temperatures to which the material has been subjected.

The volatile percentage has been given by different chemists as anything between 52·5 and 65 per cent., while "coke" or "fixed carbon" is stated at from 5 to 11 per cent. The reason for these differences is that if quickly subjected to a high temperature destructive distillation takes place with the deposit of free carbon; later at a higher temperature the free carbon, finely divided and closely associated with calcium carbonate, reacts with it, giving off carbon monoxide and thus increasing the volatile percentage, which, of course, also includes the moisture present.

A very careful distillation with gradually rising temperature will give different results and probably a greater yield of oil, but less gas.

From all the data available it seems that we may take the average

volatile percentage at from 54–56, which is extraordinarily high for a shale. Analyses of the organic contents by different authorities give the following :—

Carbon	70·52	72·82
Hydrogen	7·20	8·66
Nitrogen	0·30	0·68
Oxygen	21·98	16·24
Sulphur	—	1·60

The remarkable points to be noted are the fairly low nitrogen percentages and the very high oxygen, which suggests either that there is some water present or that the bituminous matter is highly oxidised and inspissated. The Carbon-Hydrogen ratios are 9·8 to 1, and 8·4 to 1 in the two cases. These are both very low, and would place the material among well inspissated manjaks such as W. Virginia Grahamite and Albertite from New Brunswick. It will be noted that the lowest C-H ratio is from the analysis showing the lowest oxygen ; this suggests less inspissation, but still there is a probability that some water is present. The sulphur percentage 1·60 is not high for such material, and compares favourably with Dorset and Norfolk shales. Extractions with carbon disulphide and carbon tetrachloride in a Soxhlet apparatus gave 0·9 per cent. and 0·8 per cent. soluble, according to Dr. Dunningham, results that prove that in spite of its fresh appearance the organic material is very highly inspissated.

It is quite evident, however, that much chemical work requires to be done on this interesting shale before it can be said to be fully understood.

Retorting Tests.

With such a high percentage of volatile matter is it obvious that the yield of oil per ton will be high. Theoretically over 90 gallons is possible, and has, I understand, been attained occasionally in small-scale tests, but in works practice such a result is hardly possible, since deposit of carbon and formation of uncondensible gas cannot be prevented with such a highly inspissated kerogen.

It has been found by Dr. Dunningham that distillation does not begin at very low temperatures, but that when it does begin the distillation is very rapid, and can be practically completed without raising the temperature above 450° C., or at the most 500° C.

The shale has been tried in many forms of retort with varying results, but from the writer's experience of the tests made, he is convinced that the best results cannot be obtained in any vertical retort, with or without steam. Perhaps the worst attempt at distillation of this material is that in a German vertical retort, now in operation in Esthonia. It yields from 40 to 50 gallons per ton of an oil of 0·98 sp. gr. A yield in works practice of between 70 and 80 gallons per ton, and a crude oil not higher than 0·93 sp. gr.

can be counted upon with confidence, and it may be left to the chemists and engineers of this Institution to better these results, if possible.

The Origin of the Oilshale.

Perhaps the chief interest of this oilshale to a geologist is the question of its origin; in fact, how it became an oilshale. The writer's theory of the origin of oilshale has been put before this Institution and need not be recounted here, but it may serve a useful purpose to consider the Esthonian oilshale in the light of various theories and to ascertain what we can learn from the field, microscopic and chemical evidence upon the general subject of oilshale.

Here are no igneous intrusions to complicate geological evidence, and no carbonaceous deposits; here are no difficult geological structures; here are strata of great age practically undisturbed since they were deposited and the simplest geological conditions that can be imagined.

What theories have been put forward to account for this the richest true oilshale in the world occurring intercalated with a fine-grained littoral limestone? Let us take the German theory first. H. von Winkler in the Sammlung von Mittellungen aus dem Geogogischen Institut der Universität Griefswald has dealt with the subject and calls the deposit a sapropelite, a deposit containing sapropel, the origin of which he attributes to Algæ—marine algæ, of course. He states, quite incorrectly, that the shale contains 65 per cent. of ash, and his statements are otherwise not very interesting, except that he makes an estimate of the tonnage of shale proved and puts it at 128,790,000 tons.

Now, it is perhaps arguable as to what sapropel is; so far as the writer has been able to understand those who have employed the word, it is a structureless jelly of vegetable origin which occurs in peats, and certain coals, coaly deposits, or oilshales. In fact it is a comfortable work like kerogen, used to describe something that has at least a practical existence and a theoretical value. How it has been formed and why it has no structure remain in the realm of mystery, but at least a vegetable origin is claimed for it. How such a substance could be formed and preserved under shallow littoral conditions where wave and current action were sufficient to break up into minute fragments the hard parts of sturdy palæzoic brachiopods and trilobits is not explained by von Winkler. Nor has he explained how algæ could flourish in such conditions so luxuriously as to accumulate into a deposit rich enough in organic matter to yield seventy or eighty gallons of oil per ton. Were the whole deposit nothing but the remains of marine algæ, and were the combined waters removed by some mysterious means,

some 20 or 30 gallons of oil per ton would be the most that could be obtained by distillation, and there would be mineral salts in abundance, bromides and iodides, to be eliminated, not to mention from 4 to 8 per cent. of sulphur. But the shale is composed of fine fuller's earth crowded with fragments of calcareous fossils, and the sulphur content is but 1·60.

We may, therefore, dismiss von Winkler's theory, as we have so often to do with German theories, as an ingenious explanation that has little or no relation to the facts of the case.

There has been within recent years a great deal of very loose and unscientific thinking and writing with regard to oilshale, and it cannot be insisted upon too strongly that each theory put forward must be tested not only in a qualitative but in a quantitative sense.

For instance, Mr. H. M. Cadell, of Grange, has suggested that the oilshales of Scotland have probably derived their kerogen from peat, detrital peat, washed down from the land and entombed in marine or deltaic sediment. It is an ingenious idea, apart from the difficulty of entombing detrital peat, which would remain afloat or in suspension for indefinite periods. But how does Mr. Cadell explain the yield of oil, running in some cases in Scotland as high as 35 or even 42 gallons of oil per ton, from a peat content of at best some 30 per cent.? Were the whole deposit pure peat, and were it dried as far as possible, say to 25 per cent. moisture, it would yield on distillation some 26 gallons of oil per ton. If we divide this by three we arrive at the maximum yield that could be expected were peat the origin of the kerogen of Scottish Oilshales. In fact, if we consider all possible modes of origin for the so-called kerogen we find that no other material but inspissated petroleum adsorbed by colloidal inorganic matter can give, even theoretically, the yield of oil that a rich oilshale gives under distillation.

It is, perhaps, hardly necessary to deal with a possible idea of animal origin for the organic matter in the Kukkersite, but it is always possible that someone, seeing that the beds are full of fragments of fossils, may suggest, as has been done in the case of the Dorset and Norfolk shales, that the animal matter has in some supernatural manner clung to the fragments of the hard parts while they were washed about the shore for years, and so eventually become entombed to undergo destructive distillation at impossible temperatures to form kerogen. If anyone be so enterprising as to entertain such an hypothesis he will hardly find any backing from field geologists.

But if we can only conceive of such a rich oilshale being formed by impregnation with inspissated petroleum we are met at once with the query "whence came the petroleum?" Here we must turn to the facts again.

At a comparatively short distance beneath the bands of Kukkersite we find thick beds of Cambrian Sandstone, and it was to these that the writer at once turned for evidence. They are typical oilsands, as anyone who is familiar with oilsands, especially those that have been subsequently bereft of their oil, cannot fail to recognise. Search, even in hard calcareous concretionary bands failed to find any residual traces of oil that could be detected in hand-specimens, but possibly extraction with chloroform might yield some trace from the least porous beds. The Dictyonema shale, however, associated with these sandstones is impregnated to its capacity, some 10 per cent. It is not an absorbent or colloidal shale, but it contains dark brown and highly-inspissated kerogen, as shown by microscopic examinations.

Even the limestone which is not by any means adapted for the adsorption of inspissated petroleum contains a slight impregnation, which reaches 8–10 per cent. in the thin beds associated with the shale. This, however, is not such direct evidence as we could wish, and it is necessary to make a wide and comprehensive study of the country to obtain confirmation of the suggested source of the impregnation of the shale. With such simple geological conditions there are no structures capable of concentrating petroleum towards definite localities, and therefore it is not possible to select any one district to test for the presence of residues of oil. The surface of the plateau also is so much covered by superficial deposits that solid evidence is only available here and there. Nevertheless, a certain amount of evidence has already been brought to light, and probably much more will be available later.

At Kokskar, a small island some seven miles north-east of Reval, where there is a lighthouse, in a shallow boring which penetrated into the sandstone and conglomerate immediately overlying the Archæan granite gas was struck in appreciable quantity, of which, however, no record seems to have been kept. At Kaali, near the centre of the Island of Oesel, there is a large mud-volcano in Lower Silurian strata. It is 200 metres in diameter, while the crater is 30 metres across and contains salt water, through which the gas bubbles.

At Keinis, in the island of Dago, a bore-hole 40 feet deep struck water and a little oil. Finally, in a limestone quarry near Wanamoisa, where the stone is quarried for the cement works at Port Kunda, we find thin vertical veins of manjak. This is to the best of the writer's knowledge the oldest manjak in the world, and should be consequently highly inspissated. Extraction tests with carbondisulphide and with chloroform kindly made for the writer by Dr. Frank E. Weston show that the material is entirely soluble in these liquids, that is to say, the material is 100 per cent. bitumen. This compares with 93–99 per cent. in Barbados manjak or Gilsonite,

and 2–12 per cent. in Albertite. This is a most remarkable result, seeing that the kerogen of the shale is so highly inspissated. Possibly the intrusion of these manjak veins took place at a later period than the impregnation of the shale.

Probably other similar occurrences will be discovered when more ground is opened up. The interesting point is that these veins occur actually slightly above the horizon of the oilshale, proving that intrusion of liquid or semi-liquid petroleum from below has been extended at least as far as the adsorbent fuller's earth which has become an oilshale.

The evidence is therefore complete; we have all the evidence of a former oilfield, except favourable structure to concentrate petroleum. We have the oilsands, the shales and even limestone bands impregnated according to their capacity, shows of gas—including a mud-volcano—a show of oil, and manjak veins. A simpler case can hardly be imagined and no other explanation of the origin of the oilshale will accord with the facts.

Commercial Possibilities.

A few words as to the commercial development of this remarkable oilshale may not be out of place. It has been proved in workable thickness at intervals for a distance of 36 miles from east to west, and seven miles from north to south, but to make any estimate of the tonnage available would perhaps be premature. In one locality a tonnage of over five million per square mile is assured, but this is perhaps too much to expect over a large area. But three million tons per square mile has been proved over a fairly large area, and we may take 2 or 2½ million as a very conservative estimate.

An Esthonian geologist has estimated the total available tonnage at over 3,000 million, but the writer, taking account of the variations in thickness to which such fuller's earth deposits are liable, is not prepared at present to estimate the shale in sight at more than 1,000 million tons, though recognising that further excavations may prove a very much larger quantity.

For many miles, in fact all along the outcrop and for some miles southward the shale can be worked by open cut. A steam navvy is used to remove the superficial deposit of sand, from 3 to 6 feet in thickness, and then the shale is quarried by hand labour, the limestone bands picked out, and the shale loaded in trucks. At present the Government are winning about 700 tons per day, and it is used chiefly for fuel, while the fines and smalls are sent to the cement works at Kunda, where in a crushed state the material is blown into the rotary kilns, giving a white hot flame, while the ash is incorporated in the clinker bringing it to the requisite chemical composition.

It is estimated that with a well-laid-out scheme of excavation the shale can be delivered at retorts at a cost of from 4s. to 5s. per ton.

In winter, mining will have to be undertaken some two or three miles to southward of the outcrop, but the mining will be very cheap as the cost of clearing over-burden will be obviated. The seams of shale have a good roof and floor of limestone, and what timber is necessary can be supplied from the immediate neighbourhood. An output of one, two or three thousand tons per day can easily be arranged for. Labour is cheap and plentiful.

With a yield of at least 70 gallons per ton, perhaps as much as 80, of an oil from 0·92 to 0·93 sp. gr., and containing but a small percentage of sulphur, refining should not be difficult nor expensive, especially as solid paraffins will be almost entirely absent.

Commercial details are outside the scope of this paper, but it will be seen from the brief data given above that the development and retorting of this shale and the refining of the crude oil are matters of great importance, not only to the Republic of Esthonia, but to the world at large, and very great commercial possibilities, about which the writer has no wish to make his predictions public at present, are in sight.

DISCUSSION.

The President, in opening the discussion, said the author had given a most interesting paper which was of great importance from the point of view of the commercial prospects of these oil shales in which Esthonia possessed a very valuable asset. He had also indicated that those oil shales might have from the commercial point of view even a wider interest than the Esthonian interest. Some time ago a report was published by the United States Department of Commerce in which an estimate of 1,500,000,000 tons was given for these deposits, which agreed pretty well with that which the author felt justified in putting before the members—namely, 1,000,000,000 tons. The report to which he had referred also indicated that Great Britain was not without some considerable interest in Esthonian oil shales, because it referred to syndicates which possessed options over very considerable areas of land in Esthonia. With the high yields of oil which the shale undoubtedly gave the material was of far greater value, as the author had emphasised, than the Scottish oil shale. He was not quite clear in his mind as to what yields per ton of shale might be expected. The author mentioned that theoretically there was a possible yield of over 90 gallons per ton,

and he would like to ask what was the theoretical basis upon which he made that estimate. Very frequently it was done on the amount of volatile matter in the shale, a very unsatisfactory method, as he thought all chemists would agree, and it was rendered still more uncertain in the case of the Esthonian oil shale because the mineral matter containing as much as 49 per cent., or more, of calcite or carbonate of lime. Taking this figure, it gave 22 per cent. of volatile material due to carbon dioxide alone, so that he hardly thought it could have been based on the result of ignition in the ordinary way. The statement was further made that with the German retort from 40 to 50 gallons had been obtained, and the author estimated that it might be confidently anticipated that 70 to 80 gallons per ton would be obtained in practice. He had had some little experience with samples which the author had kindly supplied to him, but there were others present who had a wider experience with retorting, possibly only on a laboratory scale. He believed, however, some present had had an experience of the Esthonian shale on a works scale, and it would be very useful to obtain the actual results in practice, as distinct from the theoretical result of 90 gallons per ton. But whatever the result, even assuming that it was only 50 gallons to the ton, the deposit in Esthonia was a remarkably rich one. Another point which occurred to him, as a chemist, was the analysis of the kerogen which was given. He was not quite clear how that result had been obtained, because those who were familiar with organic analyses would know that unless the carbon dioxide, which was inherent in the mineral matter, was got rid of, or the organic matter could be extracted completely in some way, it might be extremely difficult to make an analysis of the organic matter present which was at all correct. The author mentioned the tests made by Dr. Dunningham in extracting the oil shale with solvents, like carbon disulphide and carbon tetrachloride, and it would be very interesting indeed if some information could be given of the composition of the extract which was obtained. The paper naturally divided itself into the commercial side, the chemical side, and the geological side. Personally, he thought the geological side was of paramount interest. The author had indicated in his opening remarks that he had regarded it from that point of view, and that he hoped the members would more or less concentrate the discussion on the topic of what an oil shale was. He, the President, had read many of the authors' valuable contributions to the subject and also those of other people, but he was still doubtful as to what an oil shale was. He was still much more in doubt when he received the samples of material from Esthonia because anything more unlike an oil shale, or what one was

accustomed to consider an oil shale, it was quite impossible to conceive. As the geological side of the discussion would prove to be very valuable, he proposed to ask Prof. Watts to open the discussion from that point of view.

Prof. Watts said he did not propose to say anything about oil shales in general, but he was particularly interested in the paper and desired to congratulate the author both on the material which the paper contained and his presentation of it. The Institution was to be congratulated on hearing such a paper. His chief interest in the subject was due to the fact that a graduate of Dorpat University had been working in his laboratory on the geology of Esthonian oil shale for about two years and had published a rather important paper on it, which it was just possible that members might not have seen, as it was published by the Dorpat University. Dr. Bekker had been collecting material and working on the subject for a long time, as was proved by the fact that he had found and described no less than two hundred species of fossils in the deposit. The discovery that the deposit was an oil shale was made in rather a curious fashion. The deposit was quarried and used for the purpose of making hearths. It was found that it was a very economical kind of hearth because it was not necessary to supply it with any coal; it burnt itself, but after that there was no hearth! Dr. Bekker had satisfactorily determined that the age of the shale was practically about that of the Trenton limestone. He suggested that the author might join his old colleagues on the Geological Survey in abandoning the use of the term Lower Silurian in favour of Ordovician, which in Esthonia and in America was now generally adopted for those particular rocks and gave an accurate statement of their age. He thought the Author's description of the material was a very happy one which he had not seen suggested before—namely, that the sedimentary material was of the nature of Fuller's Earth. That probably explained a good deal. The material certainly had curious properties which were not present in any ordinary shale or clay rocks, and the composition clearly came very much within the definition of Fuller's Earth. With regard to the origin of the particular material under discussion, Dr. Bekker had drawn his conclusions from microscopic analysis and they were not in agreement with the origin suggested by the Author. Dr. Bekker found in the shale itself bodies which were undoubtedly Algae, and Algae which were so close to the existing form of Gloeocapsa that he felt practically sure they were related forms. They were very commonly present and made up quite a considerable proportion of the shale. The following quotation occurs in Dr. Bekker's report: "Recent forms of Gloeocapsa live on moist earth and

stones or on rocks in water, and form slimy coverings of different colours; as we have seen the kukkersite makes up beds of three feet; therefore, the Algae which could originate such thick deposits must have been planctonic or nectonic forms like the recent species of the genera." The speaker thought the nearest translation that could be obtained of sapropel was "nasty mess." Mud going down amongst organisms did make an extraordinarily messy stuff, in which there were lots of good things if chemical re-arrangement could take place afterwards. He could not say that Dr. Bekker had proved his case, but he had shown that there was in the mud the kind of material which gave rise to the organic value of peat mosses and deposits of that nature. He was not quite sure whether it would not be wiser to accept such a possible origin for the material which gave rise to the oil in the Esthonian shale than that it was derived from some material which, according to the author, although an admirable oil rock yielded no trace whatever of oil, and which was, moreover, of an age from which oil had rarely or never been obtained. He thought it would be better to investigate further the shale material with a view to seeing whether the origin might not be indigenous in the shale itself. That was a mere question of opinion, but every variation of opinion was likely to advance knowledge. The members of the Institution were to be congratulated on having heard so interesting an account of the remarkable Esthonian occurrence.

Dr. Perkin thought it might be of interest to the members if he showed them some of the samples of oil which had been obtained from Esthonian shale, of which he had had a certain amount of experience. It was a most remarkable shale, and until the author discussed the subject with him he called it an impregnated sandstone. The author with his great experience had taken a photo-micrograph of the material and had informed him that there was not a grain of sandstone in it. He of course accepted the author's statement and now called the material shale. He previously did not call it a shale because it did not appear to be one. There was a very similar deposit near Geneva which had the same appearance, and if the author ever inspected that material he had no doubt he would come to the conclusion that it was a shale. The paper was of extreme interest from the point of view of showing how the shales might have been produced, *i.e.*, how the organic matter might have been converted into petroleum. He was not quite sure that he agreed with the author that although the seas in Esthonia were now very low that that was the case when the oil shales were produced, because it might have been the case that the sea was at one time very deep and had got silted up afterwards. But, personally, he was

not a geologist, and the author was much better able to give an opinion on that point than he was. He had with him some samples of the oils produced from Esthonian shale which it might be of interest to the members to inspect. He had not a sample of the lightest fraction up to 100° C. The samples were produced from a three-hundredweight test, which gave an average of about 55 gallons of oil per ton. It must, however, be remembered that the shales which he tested had been lying at the wharf for a very considerable time, and he therefore might not have obtained the same results as would have been produced on the spot. But any shale which gave 55 gallons per ton was exceptional. Even the heaviest oil, the crude oil, was extraordinarily light. The lightest fraction which he exhibited was from 100° to 170°. He had quite a considerable quantity of the 100° fraction, but all of this fraction he had disposed of to the people who asked him to make the test. There was practically no paraffin wax in it, and the oils were largely paraffinoid,—very much more paraffinoid, for example, than the Scottish shale oils. The temperature of distillation he used was about 480° C. and a horizontal gas retort was used. Of course, better results might have been obtained under other conditions, but he thought that 55 gallons per ton on an experimental plant dealing with only three hundredweights was an extremely good result. Furthermore, the content of sulphur was very low, and it was one of the best oils he had come across in that respect. As he had stated, there was in the neighbourhood of Geneva a similar class of shale which might give similar results.

ANALYSIS OF OIL.

Sp. Gr. at 15° C.	0.9292
B.Th.U.	16825
Flash Point	63° F.
Sulphur	0.51%

FRACTIONATION.

Water	0.50
Up to 170° C.	25.50
170—230° C.	15.00
230—360° C.	40.00
Residue	19.00

FRACTION UP TO 170° C.

Sp. Gr. at 15° C. .. 0.7976 Flash Point .. .. 63° F.
(No Phenols.)

FRACTION 170—230° C.

Sp. Gr. at 15° C. .. 0.8903 Flash Point .. .. 142° F.

FRACTION 230—360° C.

Sp. Gr. at 15° C. .. 0.9701 Flash Point .. .. 131° F.

RESIDUE (Thick Tarry Oil).

Sp. Gr. at 15° C. .. 1.0268

He was sure all the members were extremely grateful to the author for the lucid and concise manner in which he had described a most interesting subject.

Mr. Stainer Hutchins pointed out that at different times reference had been made to the "theoretical" volatile in bituminous materials, such as oil shales and the like, and that comparison had been made between oil yields and the "theoretical" volatile in oil shales. He suggested that the present was a good opportunity to correct this confusing and inaccurate term and comparison. The "theoretical" volatile in any bituminous fuel was unknown and would presumably remain unknown. We only know that a certain bituminous material, tested in a certain manner and under certain conditions, gave a certain volatile percentage and that if we varied the method, etc., of test, we got a different volatile figure.

From certain samples of Esthonian Shale Mr. Hutchins stated he had obtained results by means of a practical, yet new method, which agreed with the figures put forward by the author, and had obtained the higher figure mentioned by the author by the same method by altering certain of the factors such as time and speed of temperature increase, the result obtained being over 90 gallons per ton. The residue was subsequently taken up to about 850° C. and very much to his surprise he found what at first appeared to be a considerable amount of additional volatile remaining in that residue, but it was found on investigation to be due to the action of limestone in intimate contact with the carbon remaining in the shale, resulting in the production of CO and CO_2.

Under proper working conditions and by the method and process referred to above, with a temperature up to 480° C. a yield of about 73 gallons of oil per ton with a specific gravity of 0.921 could be obtained. One of the important factors in obtaining these yields was the peculiar form of agitator or breaker in the retort. On tests taken with this agitator or breaker absent, although the retort was revolving, the yields of oil were reduced anything from 50 to 25 per cent.

He did not propose to put forward his theories as to why this agitator or breaker gave such increased yields, as probably a number of the members present would not agree with him, and no useful purpose would be served by putting forward theories at the present time—results were the important factor at the moment.

He expressed his deep appreciation of and complimented the author on his paper. He thought he would derive considerable benefit from it as, whilst, for comparative purposes, he was elderly in his experience on coals and cannels, he was only young in his experience on shales.

Mr. Harold Nielson said he had a small amount of experience with a rotary retort and had done a certain amount of work with it, but the oil shale used in that case did not produce more than 18 to 20 gallons per ton. He was perfectly sure that if an agitator had been used, not more than half that quantity would have been obtained. The result was probably due to the peculiar nature of the shale employed. He desired to ask a question with regard to the suggested yield of 90 gallons per ton. Taking an Esthonian oil shale, and assuming, for the sake of argument, it had about 50 per cent. of volatile matter, which included combined moisture, oil-forming matter and also gas. An oil shale containing about 50 per cent. volatile matters might contain up to 6 or 7 per cent. of combined moisture, which reduced the original figure to about 43 per cent. About 3000 cub. ft. of gas per ton would be obtained. At normal temperature and pressure that would weigh about 150 lbs., and if that figure was deducted he could not quite see that there was enough left to form 90 gallons of oil, even with a specific gravity of 0.92. Secondly, he would like to know a little more about the nature of the carbon in the spent oil-shale and whether it had any value from the point of view of making gas from it. Had an attempt been made to use it in a gas producer?

Mr. Percy Reuss said a good deal was heard at the present time about the tremendous oil contents of various shales. Attention was called to the enormous quantities of shales in Brazil, in Chile, in Esthonia, in this country and other places, but, apparently, up to the present it had been impossible to obtain a retort which enabled those valuable shales to be turned into a profitable commercial proposition. There were a number of retort makers in this country, and he desired to ask them whether a retort was likely to be produced which would make it possible, commercially, to produce oils from shales as against the competition of mineral oils. The scientific side of the question was, no doubt, most interesting to the scientifically minded, but men like himself desired to have some clear indication as to the real commercial possibilities of putting down effective retorts enabling them to sell the output at a good profit in competition with free oils. Until this essential point is satisfactorily settled it would seem useless to interest oneself further in the development of oil-shale propositions.

Mr. Gordon Pitt said the author had stated that he hoped the discussion would turn on the question of what was an oil shale, but he had very carefully refrained from giving a definition of it himself. It would be of great interest, he was sure, to most of the members to know why the author designated the material as an oil shale, and then proceeded to give a theory of the origin of the bituminous matter in it which would make

it look very much more like what one was inclined to call an impregnated rock. One of the very elementary notions which had always been present in his mind with regard to the differentiation between an oil shale and an impregnated rock was that, in a true oil shale, there was some reasonable evidence that the bituminous matter was formed *in situ*. If he was wrong about that perhaps the author would correct him. He had in his possession samples of a particular sandstone from Spain, from which could be obtained by laboratory distillation something like 50 gallons of good oil per ton. He had thought that, unquestionably, it was an impregnated sandstone, and it would, therefore, interest him very much to know what really the differentiation was between the two things. With reference to the remarks of the last speaker, a very simple calculation would give him the information he desired. If it cost 5s. per ton to put the shale into the retort, and since, as many of the members knew, a material of the nature described could be retorted under suitable conditions for something like 10s. a ton, the figure for the cost of the oil product was a fairly simple one to estimate. In that connection he desired to mention to the members a fact that might not be generally known, that some improved methods for retorting shales or mineral materials of that nature containing large quantities of oil had recently been brought to a marked pitch of perfection in America, and the Government had given great encouragement to the experiments. The experiments had been conducted on very extensive lines, but in spite of the enormous quantity of Utah shales available and their very high volatile contents, many commercial trials having resulted in upwards of 50 and 60 gallons of oil per ton, it had been decided that in view of the after treatment that was required there was nothing to be said for oil shale yet in America, which was a large natural oil-producing country. He thought that might be taken as being practically the official decision. In this and many other European countries, however, the situation was entirely different. He desired to leave with the members the suggestion that possibly this country had been going along the wrong lines as to the best method to adopt, and also to suggest that suitable retorting, combined with immediate cracking before cooling in order to get the best returns for the highest-grade product from shale oils, most of which were essentially suitable to the best methods of cracking, would be the solution of the question as to whether oil shales in general were worth working.

Mr. Evans said he had often wondered why such oil shales were not made more commercially available, and thought it must be admitted that there was a "nigger on the fence" somewhere.

It had been suggested that the provision of a suitable retort was the solution of the whole problem. He desired to call attention to the fact that quite a number of retorts were made at the present time, all of which were reputed to be satisfactory. The author had referred to the vertical retort as being a distinctly good one for Esthonian shale, but he did not give any indication of what type of retort gave the best oil. It was necessary to be a little careful in using the terms vertical and horizontal retorts, because at the present time there was a vertical-horizontal retort, which was working in this country with fairly good results. Unfortunately, however, although the retorts appeared to be quite economical, the oil which was produced gave quite a small yield of petrols to which one looked forward for a commercial return. Some of the shale oils which he had examined contained only about 6 per cent. of petrol, between 80° and 150°, and if the distillation was taken up to a temperature of 200° there was only somewhere about 17 per cent. He was afraid he could not give any details of the residue of the oils. In view of the fact that it had been expressly stated that the value of the shale oil lay in its petrol content, and in view of Dr. Perkin's statement in the course of the discussion, he was afraid that the two statements did not agree. It appeared to be very commonly assumed that shale oils were very rich in petrols. In the next place it was stated that there was only a small amount of sulphur in Esthonian shale, but unfortunately the amount of the sulphur had not been given. He would like to know whether it had been reduced in any treatment to which the oil had been subjected. Dr. Perkin, on previous occasions, had stated that the sulphur question was a very difficult one, and, personally, he knew that quite a number of shale oils had been condemned because of their sulphur content. With further reference to the petrol content, he would be extremely obliged if the author could give any idea of the distillation curve. The author had confined himself to the specific gravity, which he was afraid did not convey very much information.

In reply to a question by the Chairman,

Dr. Perkin stated that the sulphur content in the oil was about 5 per cent.

Mr. George Howell first of all congratulated the author upon a new departure in the industry, as shale development in the future was bound to play an almost predominant part in petroleum history. If economic destructive distillation treatment of the shales in America could be solved, then Americans need have no fear of ever being short of various kinds of oil. He would like the author to state whether he was absolutely certain that the formation in

Esthonia was a real shale formation, or whether it might b impregnated sandstone, like the sandstone formation near Geneva to which Dr. Perkin had referred. In New Brunswick there was a very fine exposition of shale formation, and a proposition had been made under which those shales could be worked at a very low cost; samples which he took from the property contained as high as 60 gallons per ton of shale worked.

Mr. Howell further contributed:—We are ready to agree with the learned author that the oil shales of Esthonia are the oldest and richest in the world; if not, they form, at any rate, one of the most valuable and richest shales known, and constitute the largest mineral resource of Esthonia. There is a statement that the workable deposits extend from Jewe to Wessenberg for a distance of 60 miles, with, on average, a width of six miles. This, if only partially true, evidences a vast tonnage in what, in parts, has been proved to be shale carrying nearly one-third of its weight in oil contents. In spite of this, I am of the opinion that the author is right when he cut down by two-thirds the estimates made by the Esthonian geologist; until the deposits have been carefully measured and systematic sampling and analyses obtained it would be extremely unwise to place the reserve at more than the 1,000,000,000 tons, it is liberal enough. There need be no anxiety of the oil values contained in the shale, it has been fully confirmed by practical demonstration; and the Esthonians, like the ancient Egyptians, soon learnt to make the fullest use of their natural resource, and nowhere in the world is there so wide a use made of shale and its products as in Esthonia. As fuel, the shale is used in a variety of ways, firing locomotives; in the Reval gasworks for the production of gas, thousands of tons of shale have been used periodically; in cement works, principally at Port-Kunda; under stationary boilers, where facilities for handling a great amount of ash are available; in cooking stoves, open grates, etc., in steamers, and for lime-burning, etc. These are only a few of the uses this crude oil shale is put to, in addition to its values obtained by destructive distillation.

The analyses of Kukkersite offer sharp contrast with those of other shales:—

	Kukkersite.	Torbanehill.	New Brunswick.	Colorado.
Carbon	70.52—72.82	66.00—64.02	87.25—85.40	45.00
Hydrogen	7.20— 8.66	8.88— 8.90	9.62— 9.20	21.70
Nitrogen	0.30— 0.68	0.65— 0.55	1.75— 3.06	6.10
Oxygen	21.98—10.24	2.99— 5.66	1,21— 2.22	—
Oxygen (free)	—	—	—	0.20
Sulphur	1.60	0.70— 0.50	Traces only.	1—2%
Ash	—	21.18—20.32	0.17— 0.12	—
Hydrocarbons	—	—	—	24.60

Mr. E. H. Cunningham Craig, in reply, said that so many points had been raised that he would have to answer them very briefly. He desired to say, first of all, that he had attended the meeting to describe and discuss an oil shale and not a torbanite, nor a retort, nor any chemical matters whatever. He, therefore, thought it was rather unfair he should be asked all kinds of conundrums upon chemistry and retorting. He knew something about retorting, but he did not propose to say anything about it on the present occasion. Personally, he was not responsible for any of the analyses given; he had taken them as he found them. There was one great point to be noted about the difference in the analyses. The shale did vary considerably. For instance, at Wanamoisa, where the Government had done a great deal of excavation work, the shell fragments in the shale were few compared with the great openings at Turpsal where the big excavation was made, and the result was that the volatile was considerably higher. He was able to tell the members what oil shale was on general principles. Oil shale, as he understood it, was a colloidal combination between colloidal inorganic matter and colloidal petroleum, and to get a really good oil shale that petroleum must be fairly-highly inspissated. Those were the essential matters, and it did not matter whether it was called an impregnated rock or a highly-inspissated oil shale from which little or nothing could be extracted by solvents. In reply to Prof. Watts, he could only say that the days were so long ago since he dealt with the words Ordovician and Lower Silurian that he was afraid he was quite behind the times. He desired to make one point, however, with regard to the algae. It was quite likely that algae were to be found in that oil shale. Some of the appearances he had seen in it might be taken for algae, but they might not be algae at all. For instance, there were some very wonderful flocculent red masses which were particles very rich in ferrichydroxide, and it certainly suggested that there had been a precipitation of flocculent hydroxide. Their shapes might resemble algae, but he thought it would be very difficult to prove it. It was necessary to deal with the kerogen of oil shale, not only in a qualitative, but in a quantitative sense. If the whole mass of the deposit was made of algae and nothing but algae, it would yield in retorts certainly not more than about 30 gallons of oil per ton, a great deal of sulphur, and a great deal in the way of mineral salts, iodides and bromides. These were not obtained in the Esthonian oil shale; on the other hand, up to 70 or even 80 gallons of oil per ton were produced and very little sulphur. He did not think, therefore, the algae hypothesis would hold in that case any more than it did for torbanites. In answer to Dr. Perkin he did not pretend that the sea was exactly the same in Ordovician

times as it was at present, but the deposits were formed along a low shelving shore line. It was possible to see the same kind of deposit being found in many places to-day where comminuted shells formed a large part of the bed. Such deposits were formed very slowly, and were generally rather muddier than in the present case. In answer to Mr. Nielsen, the average volatile content was on analysis between 54 and 56. He also wished to point out, with reference to the question about retorting, that if retorting was performed with the object of making gas, say 3000 ft. as Mr. Nielsen had mentioned, not so much oil was produced, but if retorting was done for the purpose of making oil, so much gas would not be produced, and more of the weight of the volatile would go into the oil. In answer to Mr. Reuss, the retort question was a very serious one. He had not intended to discuss the question of retorts, but he desired to point out that there were a great many retorts that would do the work well and would give oils of good quality from various materials. The retort which was the cheapest to erect and to work was the one that would succeed. A cheap retort that was foolproof and almost automatic was what was required. There might be others that gave greater yields and perhaps a slightly better quality of oil, but it was not so much oil that was required to be obtained from rich shales as £.s.d., or Esthonian marks as the case might be. With regard to the question that had been asked as to how oil shale could stand against free petroleum, it all depended upon where the shale was. America was an oil-producing country, and with oil fields not very far away it was very difficult to make even the rich shales of Colorado pay. But Esthonia, Finland, Norway, Sweden, the northern part of Russia and Germany all wanted oil; they all had to import it; and when the only competition was oil brought from far overseas, it would at once be seen that that was a favourable condition in which to develop an oil shale.

The President called attention to the fact that the present was the concluding meeting of the Session, and that the next meeting of the Institution would be held in October. He also directed attention to a leaflet which was included in the last issue of the Journal in reference to the small book on the petroleum industry which the Institution was bringing out, and which was now ready for issue to the Press and to the public. In conclusion, he moved a hearty vote of thanks to Mr. Cunningham Craig for his excellent paper.

The resolution of thanks was carried by acclamation and the meeting terminated.

Contribution from **Mr. A. Beeby Thompson**:—

Mr. Cunningham Craig's paper contributes to a subject yearly attracting increased interest. Having, during the last 15 years, investigated many shale deposits, one is aware of the pitfalls that have so far rendered practically all shale propositions unprofitable except in Scotland. One of the greatest difficulties is the variation in quality of the shale and the intercalation in the main seams of numerous bands of barren or low grade shale or even other material. Whilst, therefore, picked samples give unusual yields, the average of a seam may fall below that commercially possible to work. In such cases, handpicking has to be resorted to before passing the excavated material to the retorts.

The photograph shown on the screen indicated the prevalence of this characteristic, and it would be interesting to know whether the retorting of the whole unsorted bulk would not reduce the average yield below a profitable basis even if the limestones did not introduce special retorting difficulties. The varying analyses made by different chemists appear too large to be accounted for by difference of methods of testing, and would suggest considerable changes in the richness of the shale.

The large amount of moisture mechanically held by the shale, and that it would be necessary to extract before retorting, may introduce a problem of some complexity in a climate like that of the Baltic provinces where the summers are brief and the atmosphere is humid.

An acceptance of Mr. Cunningham Craig's theory of origin necessitates a complete revision of one's ideas of oil concentration. Whilst it has been generally accepted and demonstrated by experiments that the force of capillarity causes oil to concentrate in the coarser sediments through displacement of oil by water from the finer, Mr. Cunningham Craig's theory would involve the reverse movement of a transference of oil from coarse to the finer sediments. It likewise upsets the generally-accepted view that oil was in most cases formed in the shales and migrated to the sands in which it is now usually found; and it seems remarkable that the sands, if formerly impregnated, should betray such little traces of a former presence of oil beyond these peculiar but sometimes misleading characteristics that instinctively attract an experienced prospector's notice.

In many oilfields the clays and shales separating the oil-yielding sands that form the oil-measures are heavily impregnated with oil, but these shales betray no similarity to oil shales in which the oil is mainly or exclusively derived from certain so-called kerogenous material distinguishable under the microscope. No

mention is made in the paper of nitrogen contents. As the production of sulphate of ammonia has been the main factor in the success of past oil-shale propositions, any data on this subject would be of interest.

Anyone who has experimented with oil shales appreciates the influence of the methods of retorting on the character of the crude oil. In many cases the methods yielding the best results cannot be reproduced on a commercial scale for one reason or another.

Contribution from **Prof. T. G. Madgwick**:—

This paper is a valuable one, both in that it describes an interesting occurrence of oil shale and from the fact that the author gives us detailed views on the mode of its formation. It is this latter side which seems most suited for a discussion. I have not had a chance of reading Von Winckler's paper on these shales, but there does not appear any reason why his deduction of the "sapropel" in this case necessarily involves the entombment of the marine *algæ* more or less *in situ*, any more than that the hypothesis of the peat origin of the "kerogen" of the oil shales of Scotland implies the burying of detrital peat as such. Few advocates of such hypotheses nowadays would argue in favour of such an unlikely procedure, but are prepared to let the material have gone to a much more advanced stage of decomposition prior to its deposition. Thus, Murray Stuart in 1910[1] put forward a sedimentary deposition of oil based on observations of the behaviour of oil in the streams and swamps of Burma, how that the oil is carried down to the bottom of the water in small globules by adhering tiny particles of mud, thus forming a deposit of mud containing globules of oil and saturated with water. He supported these observations by experiments with Yenangyaung crude agitated with water and finely-divided clay and allowed it to settle when, under the microscope, the oil was found mechanically mixed with the sediment and held by it. His interesting discussion deserves careful study by all interested in this fascinating problem, quite apart from the importance one may attach to the views put forward in relation to silicified tree trunks as the source of Burma oil. It is worthy of note in passing that this association of tree trunks with oilfield facies is not confined to Burma, for they form a well-defined horizon in the Apsheron fields and are ejected by some of the mud volcanoes.

This phenomenon of the disappearance of oil from the surface of running water is one we have doubtless all noted. With high-

[1] *Rec. Geol. Surv. India*, vol. xl., 1910, pp. 320–333: "The Sedimentary Deposition of Oil."

grade oil in ordinary stream seepages it appears as if an emulsion is soon formed of the film of oil on the surface of the water before the film has travelled far from its source, and this emulsion clings to the vegetation of the banks and disappears, quite how is never obvious.

The geological conditions in Esthonia appear to resemble those which are found in the Egyptian oilfields. Upon the Archæan granite we have thick beds of Cambrian sandstone and then alternating clays, shales and sandstones including the oil shales. In Egypt, equally, we have the Nubian sandstone resting upon the ancient metamorphics, and, as pointed out by W. F. Hume,[2] "the oil has a frequent tendency to collect in the fine sands (associated with shales) which form the transition between the Nubian Sandstone and the first fossiliferous limestones immediately above this formation." He proceeds to point out that "its position, however, in the beds which are formed where deposits derived from land-erosion are coming to an end does raise the question whether, *if primary*, the oil may not originate from the vast amount of organic material which must be carried from the continent to the sea, and which, if carried down with the finest clayey material, would be sealed up in the clay thus forming at the bottom of the sea."

"Vegetable remains are known to be abundant in these deposits at this horizon over wide areas."

The subject has been taken a stage further by Colin C. Rae in his paper on "A possible Origin of Oil,"[3] in which he calls attention to the possible intermediate role between the complex plant compounds and the petroleum hydrocarbons played by humic acids or associated organic compounds, probably collected by surface waters and concentrated in certain areas by means of precipitation by electrolytes, which would be contained in sea water or possibly in various inland seas or lakes.

Thus, "the analyses of various river waters show a close relationship between the amount of organic matter and the amount of free uncombined silica," and in tropical rivers such as the Uruguay up to 44 per cent. of free silica, probably in the colloidal state has been found. The coagulation of organic matter, colloidal silica and sulphur can be effected by sea water, owing to the presence of the needed electrolytes. The resulting siliceous ooze might be incorporated into some form of marine deposition, probably forming a shale with the fine mud carried by the mechanical action of river waters. The soundings of the Challenger Expedition

[2] *Petroleum Research Bulletin No.* 4. Ministry of Finance, Egypt, 1918: "Preliminary Geological Report on Gebel Tanka Area," p. 15.

[3] *Trans. Am. Inst. Min. and Met. Eng.*, No. 1137-P., Feb., 1922.

showed "siliceous ooze" existing along the "mud line" of the oceans many miles from the mouths of rivers; hence it would be possible to have diatoms for foraminifera in the formation formerly containing organic material.

These ideas are illuminating and need not apply only to organic material of vegetable origin. If accepted they dispose of the difficulties raised by Mr. Cunningham Craig as to the high oil content in the oil shale as compared with the lower possible content if it were derived from entire *algæ* or from pure peat as the case may be. As to whether we need confine ourselves solely to land life in this process I have considerable doubt. All travelling by sea have noticed on the surface of a calm sea the "oiliness" which is usually ascribed to currents alone. In the Red Sea I have noted, where an on-shore breeze prevailed and the shore was fringed by coral reefs, that such "oily" streaks could be seen starting from the outer edge of the reef, and where, reaching the shore, give rise to a foam which could be gathered up in handfuls, having the smell of seaweed and often accompanied by fragments of weed. The amount of seaweed decaying must be enormous, and, supposing such to form intermediate compounds of the kind just considered, even in the thinnest films, we should have the right conditions, supposing it is coagulated by meeting the right kind of current and is then carried to the sea bottom, for the formation of vast quantities of "sapropelites" or "kerogen shales." The process would have the merit of being a continuous one, and the material, whatever it may be, must go somewhere.

In Egypt I am certain nobody would attempt to derive the oil in the cretaceous shales from the Nubian sandstone, and, by similar reasoning, the derivation of the kerogen in the Kukkersite from the Cambrian sandstone does not appear very justifiable.

Contribution from **Mr. James Romanes**:—

The theory of origin of oil shales put forward by Mr. Cunningham Craig, whilst possibly providing an explanation for the apparent richness of the shale, appears in this special instance, at least, to create many more difficulties than it explains.

Mr. Cunningham Craig refers to the Cambrian sandstones as "typical oil sands," though admitting that when examined they showed no trace of oil; few geologists will be willing to admit that oil sands have such pronounced characteristics as to be recognisable in the absence of oil.

In the case of the Esthonian oil shale the theory put forward would necessitate, as pointed out by Prof. Watts, the occurrence of an oil sand of considerably greater age than any yet known.

Granting, however, that the Cambrian conglomerates and sandstones were originally oil-saturated and that the oil shales were then represented by a highly-absorbent deposit resembling Fuller's Earth, by what means was the oil content transferred from the one to the other? Remembering that the Cambrian and Ordovician are unfolded and presumably unfaulted, one has to account for a body of inspissated oil, originally contained in the lower sandstones, being transferred through 150 ft. of clay, 11 ft. of glauconitic sandstone, and two bands of Dictyonema shale, and concentrating itself in the Fuller's Earth. This has to take place without leaving behind any trace of the migration beyond a certain amount of bituminous material in the Dictyonema shales and limestone bands, which might well be due to formation *in situ*, and, therefore, gives no direct evidence of migration. How any such migration could so completely clear a sand of inspissated oil as to leave no visible trace is hard to understand. In fact, had the succession as described been folded, and had the lower sandstones been known to contain oil, most geologists, possibly including the author, would have described the clays and Dictyonema shales as forming an ideal cover to prevent migration of the oil.

If the theory of impregnation by migration is correct, then one would expect to find significant changes of content in the oil shales above and below the intercalated limestones, which must have had a local influence on the migration of the oil. Also, if this mode of origin applies to oil shales generally, it would be expected that, in folded areas, a distinct relationship between the oil content of the shales and the tectonics of the area would exist, and it would be interesting to know if any such relationship has been noticed by the author.

Petrols for Road Vehicles and Aircraft.

A Discussion on the Effect of Fuel Composition upon Engine Performance.

By Oliver Thornycroft, O.B.E., B.A.

Note.—This paper formed the subject of a lecture given by the author at the Sir John Cass Institute of Technology, in February of this year.

Heat Cycle and Efficiency.

One of the most important objects in an engine is to convert as large a proportion as possible of the heat of its fuel into mechanical energy. The term "Efficiency" is used here solely to express the ratio of the energy output to the energy (or heat) input. It is well to make this definition because there exists in some people the bad habit of talking of efficiency when meaning power per unit of weight of an engine.

The heat cycle almost universally employed in engines using volatile liquid fuels is approximately as follows:—

Air is compressed adiabatically.
Air is heated instantaneously at constant volume.
Air is expanded adiabatically.
Air is cooled instantaneously at constant volume.
Fig. 1 illustrates the relation between pressure and volume.

Actually, of course, the air is exhausted and a fresh charge of cold air is taken in, but this does not affect the theoretical consideration. The above cycle clearly could be completed in two strokes, one of the piston into cylinder and one out, the heating and cooling being carried out instantaneously at the dead centres. In the most common type of internal-combustion engine the working cylinder is used also as a pump, first to expel the hot air after expansion, and then to draw in cold air prior to compression. Now, it can be shown that the efficiency of this heat cycle depends only on one condition, namely, the expansion ratio (which is the same as the compression ratio)—i.e., the ratio of total volume after expansion to the volume before expansion.

Fig. 2 shows the relation between the "air cycle efficiency" and expansion (or compression) ratio. It is evident that apart from all

other considerations it is desirable to make the compression (or expansion) ratio as large as possible. The interesting point in connection with the petroleum industry is that the possible compression ratio is governed to an enormous extent by the nature of the particular hydrocarbons composing the fuel.

Deviations from the Perfect Heat Cycle.

Before proceeding to examine the effects of the different hydrocarbons, some of the practical deviations from the perfect heat cycle

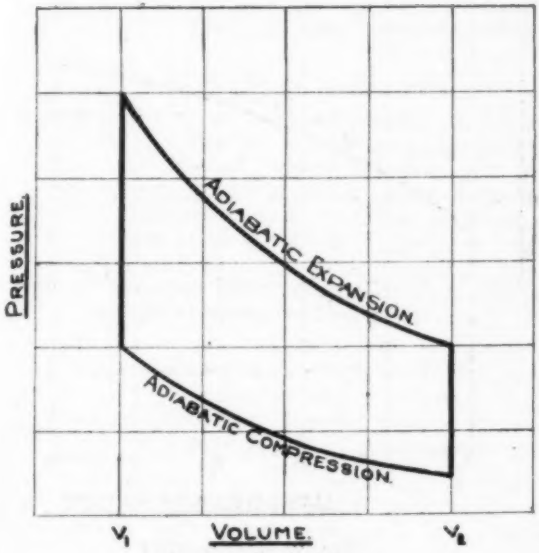


Fig. 1. (See p. 376.)

already described may be considered. In practice it is clearly impossible to heat the air instantaneously. Actually, most of the heat is produced while the piston is near its topmost position in the cylinder, but owing to various causes, such as slow inflammation, also due to delayed combustion caused by dissociation, or more truly non-association, heat is given to the air to a certain extent during the expansion period. This naturally produces a loss of

efficiency. Another important deviation from the perfect heat cycle is due to the increase in true specific heat of the gases at high temperatures. The change in specific heat has the effect of suppressing some of the sensible heat, so that the temperature, and therefore the pressure before expansion, is not so high as it would be if the specific heat of the air were constant.

The theoretical examination of the effect upon engine efficiency of dissociation and increase of specific heat of the various gases in

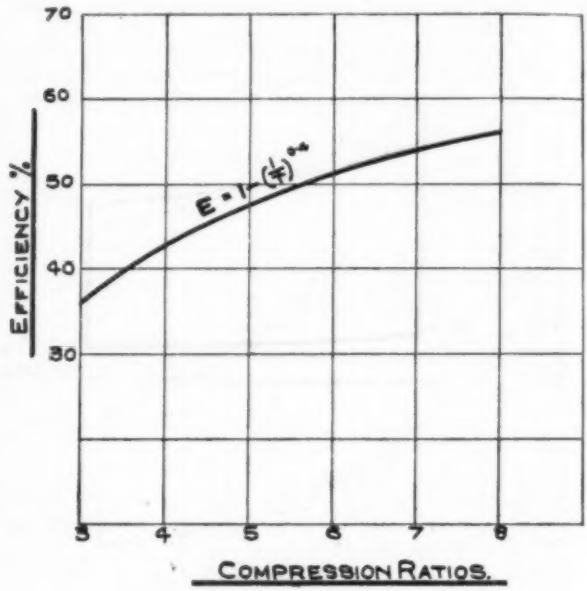


FIG. 2. (See p. 376.)

the cylinder shows that when the air fuel ratio is that giving complete combustion (both of the fuel and of the oxygen) the maximum temperature must be about 2600° C. instead of 3000° C. for a 5 : 1 compression, a drop of 400° C. below what would be obtained by instantaneous heating by complete combustion to carbon dioxide and water and if specific heat were constant. Fig. 3 shows the approximate temperatures at different points in the cycle for a compression ratio of 5 : 1. The dotted line indicates the calculated

temperatures, assuming that there is no dissociation or change of specific heat.

If less fuel is added then clearly the air is less heated and the lower temperature allows of more complete oxidation to take place immediately, with the result that the actual maximum temperature is nearer to the theoretical value, and the actual efficiency is therefore nearer to the air cycle efficiency. In Fig. 4 is shown the effect of reducing the amount of heat given to the

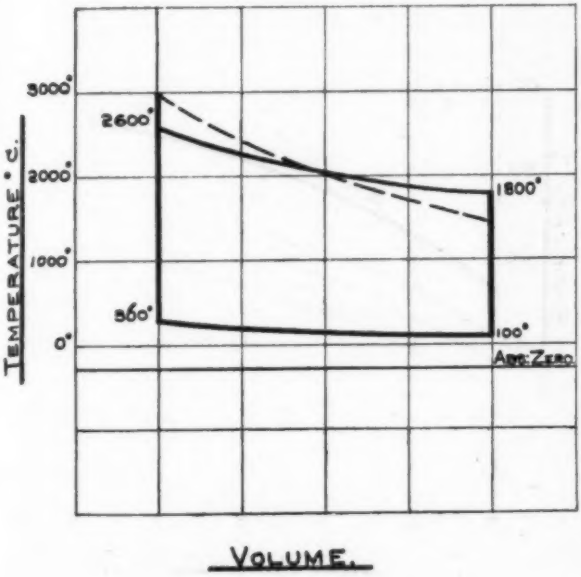


FIG. 3. (See p. 378.)

air by weakening the mixture strength of fuel to air. The upper curve shows the air cycle efficiency for any compression ratio between 3 : 1 and 8 : 1. The values given by the three lower curves are calculated by Messrs. Tizard and Pye, assuming that there is no heat loss to the cylinder. They may, therefore, be termed "ideal efficiencies" for the varying mixture strengths and compression ratios. For any compression it is seen that the weaker the mixture strength, the more nearly the actual efficiency will

approach the air cycle value. In fact, when the fuel is reduced to zero, and the heat added is infinitely small, the ideal efficiency equals the air cycle standard. Clearly the condition of no heat input is a useless one, since the power output of the engine would then be infinitely small. It would, however, be extremely useful for nearly all purposes if it were possible to work down to, say, one quarter load on the engine, with correspondingly increased efficiency.

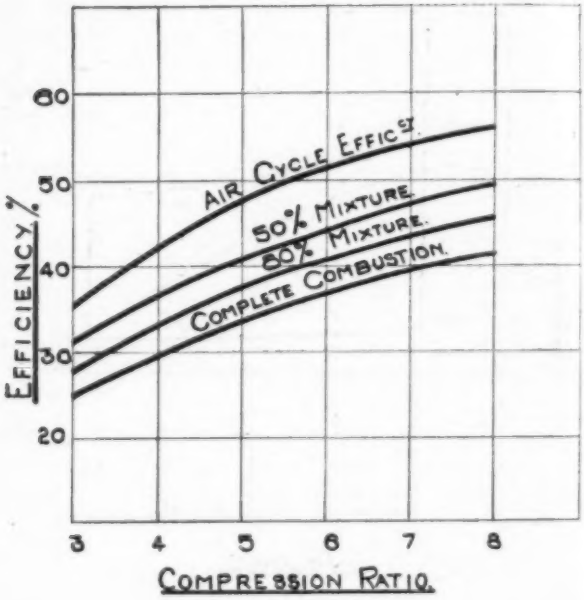


FIG. 4. (See p. 379.)

As is well-known, without stratifying the fuel vapour so that it is not over-diluted with air before combustion, it is not possible to weaken the mixture below about 80 per cent. of normal. Below this mixture strength inflammation becomes so slow that the loss more than balances the theoretical advantage due to the less degree of dissociation at the lower temperature. Fig. 5 gives the observed "indicated thermal efficiency" with a certain single-cylinder engine as the mixture strength is varied. The curve shows

that the maximum efficiency is obtained with a mixture strength of about 85 per cent. with benzene vapour as the fuel. The point where the curve is stopped at the weak end indicates where inflammation becomes so slow that further weakening of the mixture is impossible. The familiar "popping back" then occurs in the ordinary internal-combustion engine.

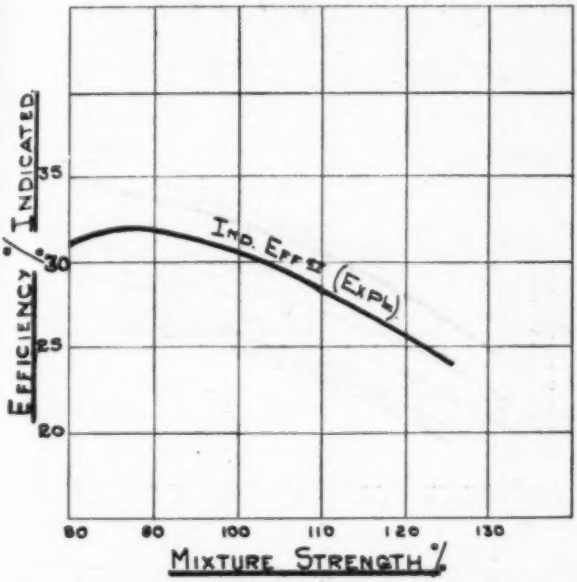


FIG. 5. (See p. 380.)

RELATION BETWEEN ACTUAL EFFICIENCY AND COMPRESSION RATIO.

From theoretical considerations of the air cycle it is clear that efficiency varies with compression. It is only in quite recent years, however, that it has been calculated (and was proved later by experiment) that with higher compressions the actual efficiency approaches more nearly to the air cycle standard than at lower compressions. The author believes it was in the variable compression engine belonging to the Asiatic Petroleum Co. at Ricardo and Co.'s Laboratory at Shoreham in Sussex, that this fact was proved experimentally for the first time.

In Fig. 6 is shown the observed "indicated thermal efficiency" with this engine for compressions from a ratio of 3·5 : 1 to that of 7·5 : 1. For each compression the efficiency is shown for the most economical mixture strength at that compression. The air cycle efficiency is shown by the dotted curve. It may be seen that the ratio between the experimental efficiency and the air cycle efficiency is increasing with increased compression ratio. This relation is known as the "Relative Efficiency."

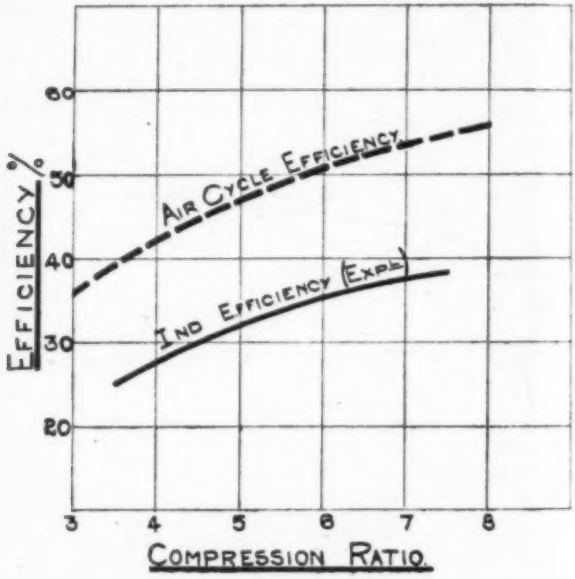


FIG. 6.

Fig. 7 gives the relation between this relative efficiency and the compression ratio for the variable compression engine. At first sight the increase of Relative Efficiency with increased compression might be unexpected, since both the adverse changes in specific heat and in dissociation will be greater with the higher temperatures due to the greater compression. As against this, however, the greater pressure very much reduces the extent of the dissociation, and Messrs. Tizard and Pye's calculations showed that there would actually be a gain of relative efficiency with higher compression.

The Effects of Various Fuels on Efficiency.

Although, of course, the relative proportions of carbon and hydrogen in the many possible motor fuels vary enormously, the efficiency of the cycle at any compression is practically constant, for all the hydrocarbon fuels provided that there is no detonation, and that the fuel and air is intimately mixed in suitable proportions for burning rapidly.

The reason for this rather remarkable fact of practically equal efficiency for all fuels is that, while for CO_2 the dissociation is

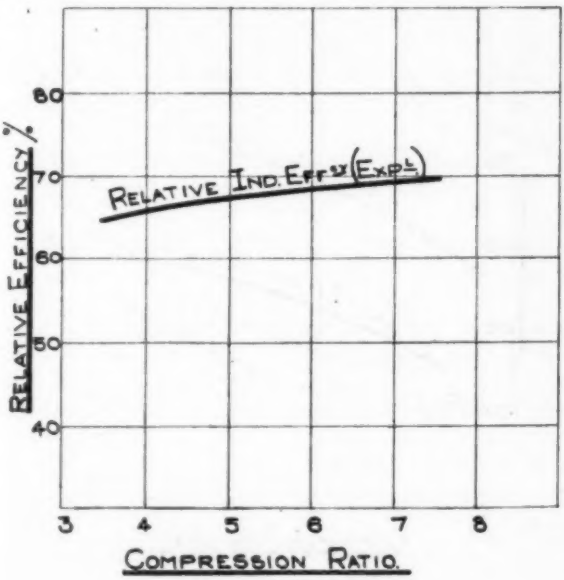


Fig. 7. (See p. 382.)

great at high temperatures, the increase in true specific heat is small. On the other hand, for H_2O the dissociation is small at high temperatures, while the increase in true specific heat is very great.

Curiously enough these effects almost exactly balance one another, so that the *sum* of the losses is practically constant.

Fig. 8 shows the rate of fuel consumption in pounds per horse-power hour for Benzene, and for a sample of Hexane when the mixture strength is varied, but at a constant compression of 5 : 1.

It is seen that the minimum consumption for Benzene is 0·458 lbs., while that of Hexane is 0·411.

The effective heat value, however, of these fuels was respectively 17,460 B.T.U.'s and 19,390 B.T.U.'s per lb. Multiplying the consumptions by the heat values we have for Benzene 8000 B.T.U. per I.H.P. hour, and for Hexane 7950 B.T.U. per I.H.P. hour. The observed efficiency is therefore the same within about ½ per cent. even for fuels so widely different as a pure Aromatic and a pure Paraffin hydrocarbon.

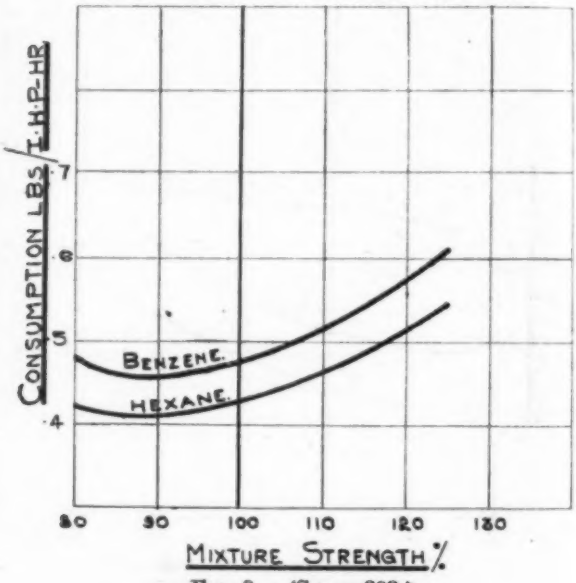


FIG. 8. (See p. 383.)

Fig. 9 gives the same values of consumption but in terms pints. Owing to the much greater density of Benzene it is seen that the relative positions of the curves are almost exactly reversed. From the point of view of road vehicles the consumption in terms of volume is the important consideration, i.e., the values given in Fig. 9. For aircraft, where the weight that can be lifted is limited, it is the consumption in terms of mass (Fig. 8) which is of greatest consequence. If some means could be discovered by which Hexane could be used at as high a compression as Benzene, it would clearly be a far better aircraft fuel.

It is found that with any fuels consisting either wholly or of mixtures of Paraffins, Olefines, Naphthenes, or Aromatics, the efficiency is the same for the same compression. That is to say, the minimum consumption is inversely proportional to the effective heat value. The effective heat value is the "Lower Calorific Value," since the water formed by combustion is not condensed, so that the latent heat of the steam is completely wasted. The effective heat value also is the "Lower Calorific Value," plus the latent heat of evaporation of the liquid fuel, since, in the engine,

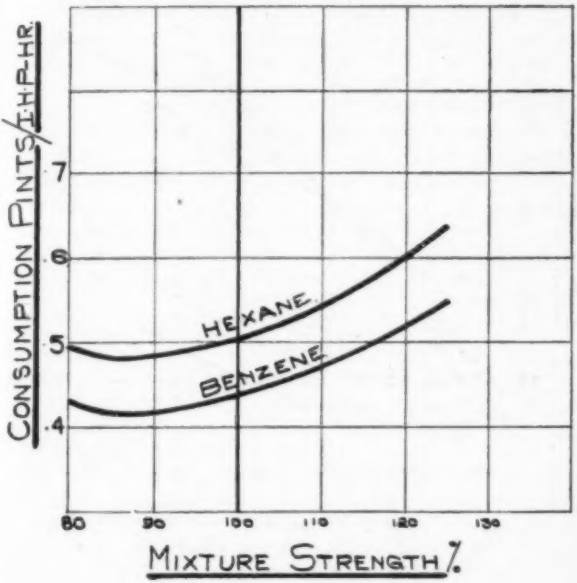


FIG. 9. (See p. 384.)

the heat of combustion is not used to evaporate the fuel, whereas in the bomb calorimeter it is.

Fig. 10 shows the observed percentage increase in efficiency as compression ratio is increased. In this same figure the percentage increase in maximum power, as observed in the single cylinder variable compression engine, is given. The rate of increase in the air cycle efficiency is shown by the dotted curve.

Summing up what has been arrived at so far :—

First.—There is steady increase in Efficiency with increased compression.

Secondly.—The rate of increase in Efficiency with increased compression is actually greater than that of the Air Cycle Efficiency.

Thirdly.—All hydrocarbon fuels give the same Efficiency at the same compression, provided that: (1) There is no excessive detonation. (2) There is a sufficient degree of volatility to give complete vaporisation before the heat cycle commences, that is, before compression begins.

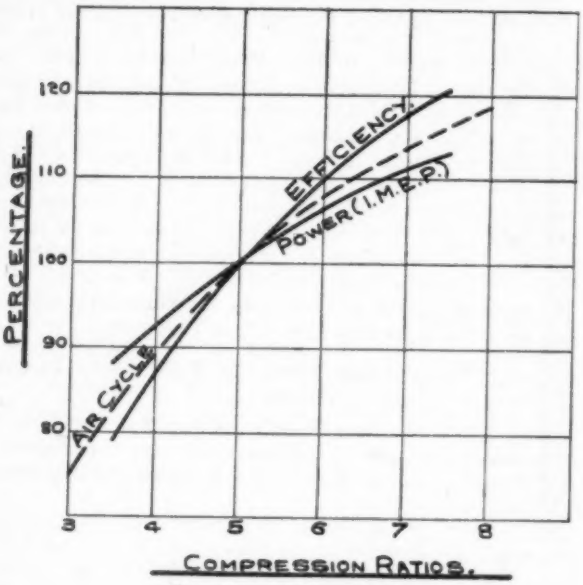


FIG. 10. (See p. 385.)

RELATION BETWEEN MAXIMUM POWER AND COMPRESSION RATIO.

The object of an engine designer is to obtain, besides as high an efficiency as possible, also as great a power as possible from a given size of cylinder.

Apart from considerations such as the mechanical strength to withstand high pressures and the ability to run at high speed, the object clearly is to obtain as high a Mean Effective Pressure as possible, and therefore as much work done on the moving piston as possible in every cycle of the engine. The work done per cycle clearly depends directly on the weight of air consumed, also directly

on the total energy liberated by combustion per unit weight of oxygen present, and finally on the heat efficiency of the cycle. Just as it was seen that heat efficiency increases with increase of compression, so also therefore must the work done per cycle, and therefore the Power, increase as the compression ratio is raised.

Fig. 10 illustrates the percentage increase if the power output or mean effective pressure at a compression of 5 : 1 is taken as 100. The curve shows the observed increase (per cent.) for a mixture strength giving maximum power at each compression. Here it will be seen that, unlike the Heat Efficiency curve, the curve for Power rises less rapidly than the Air Cycle curve. No complete explanation has yet been given of this phenomenon. *Air* consumption tests have shown that, with a variable compression engine, less air is consumed at high compression ratios than at low ones. That is to say, the "Volumetric Efficiency" at full throttle, and at any engine speed, is lower at higher compressions. It was interesting to find from these air-consumption tests that the observed power output relative to the observed heat efficiency was depressed at high compressions to the same extent as the volumetric efficiency. The author knows of no explanation, however, as to *why* the volumetric efficiency should be lower at high compressions than at low ones.

The Effects of Various Fuels on M.E.P. or Maximum Power.

As in the matter of heat efficiency, so also with regard to the power obtainable at any compression, no one hydrocarbon is appreciably better than another. This is an unfortunate circumstance for vendors of petrol "dopes."

Though the heat of combustion per gram molecule of air-fuel mixture for the Aromatics is about 2 per cent. *greater* than for the Paraffin series, the increase in specific volume due to combustion is, for the Aromatics, about 3 per cent. *less* than for the Paraffins. This appears to leave about 1 per cent. in favour of the Paraffins. Actually, however, there is a further point to the advantage of the Aromatics, namely, their rather greater latent heat of evaporation. By the evaporation of Heptane in sufficient air to give just complete combustion the temperature of the mixture is reduced by 18° C. With Toluene the temperature is reduced by 22° C.

With the slightly cooler charge using Toluene 1 per cent. more air is drawn into the cylinder, with the result that power output becomes the same to within a quarter of 1 per cent. Numberless experiments have confirmed this result.

At equal compressions it is only with Alcohols and similar bodies having a much higher latent heat of evaporation that any measurable increase of power output has been observed.

Summarising the remarks made on maximum power:

Firstly.—Power output increases with Compression ratio, but less rapidly than the Fuel Efficiency, and slightly less rapidly than the Air Cycle Efficiency.

Secondly.—All hydrocarbons give practically the same M.E.P. or Maximum Power at the same compression, provided there is no detonation.

Detonation and Preignition.

The limit to which compression ratio can be increased, and this, as we have seen, means the limit to which Efficiency and Power can be increased, is fixed by the conditions which produce Detonation or Preignition.

With all known petroleum spirits detonation precedes preignition. Only with compounds (ether is one) with uncommonly low temperatures of ignition, or with compounds (Benzene is one) with extremely high detonation points, does preignition occur without preliminary detonation.

For all petrols, therefore, detonation forms the barrier to getting higher efficiency and power. By detonation in an engine is meant what is sometimes called "pinking" or "knocking." It probably is a very similar effect to detonation in a solid, that is the extremely rapid propagation of the chemical action, the speed of transmission being dependent probably on the speed of sound in that medium.

Though there is little, if any, evidence that detonation in itself is harmful to the structure or bearings of an engine, yet, for some reason not yet explained a little power is lost due to detonation, and if it is long sustained it undoubtedly heats the igniter very considerably above its normal working temperature with consequent preignition. Preignition, which means ignition during the compression stroke, completely upsets the heat cycle, with the result that efficiency and power may soon fall to zero.

Influence of the Various Hydrocarbons on Detonation.

Of the constituents of petrols the Paraffins are the worst detonators, the Olefines (probably) are next, the Naphthenes are next best, and the Aromatics are by far the best.

It is found as regards detonation that mixtures of these bodies obey the ordinary proportional laws. This also is a sad fact for "dope" merchants who exist on the apparently vain hope that a *minute* proportion of *something* will produce an astonishing effect.

It is an odd circumstance that there is a practically straight line relation between the mixture proportions of two or more hydrocarbons and the compression ratio at the detonation point.

In Fig. 11 is shown in full line the relation between compression ratio at the detonation point and the weight percentage of Benzol in the fuel made up of varying proportions of Benzol and pure normal Heptane. The straight dotted line, it is seen, follows the curve closely, except where the proportion of Benzol is very great.

It is convenient therefore so far as possible to give to each hydrocarbon a value in terms of the compression ratio at its detonation point. Unfortunately, only a comparatively few of these bodies have been obtained reasonably pure ; a very few have been obtained

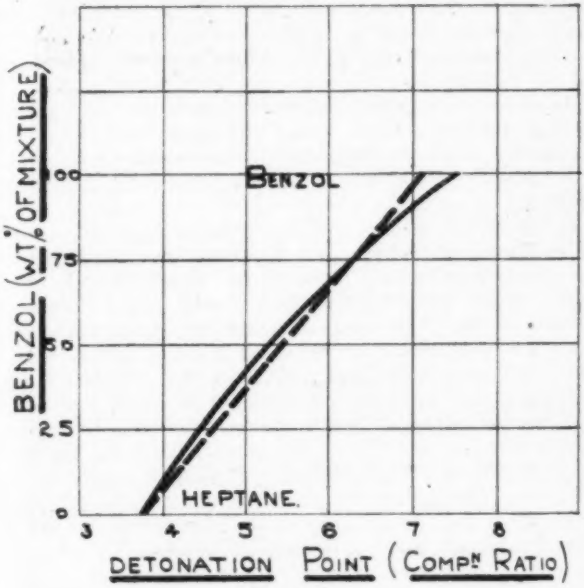


FIG. 11.

quite pure. However, from a great number of experiments, both on the few pure substances and on mixtures, the compositions of which were fairly accurately known, it has been possible to estimate the compression ratio of the detonation point for a number of hydrocarbons when used as fuels in a particular engine and under certain fixed conditions with fair probable accuracy.

In the variable compression engine (with which these tests were made) under the standard test conditions, it is seen that normal Heptane has a detonation point, or highest useful compression, at a ratio of 3.75 : 1. The effective value for Benzol (a hypothetical

mixture of Benzene, Toluene and Xylene) is a compression ratio of 7·1 : 1 in this engine and under these conditions. (See Fig. 11, where the mean straight line meets the 100 per cent. Benzol level.)

Now, in order to eliminate the constants due to this particular design of engine and conditions of tests, it is proposed to take the compression ratio of 3·75 : 1 as being zero and that of 7·1 : 1 as being 100. The " benzol value " of normal Heptane then becomes 0, and that of Benzol 100 ; and the compression ratio at detonation point of any hydrocarbon or mixture thereof can be expressed on this new scale, that is, it can be given a " benzol value."

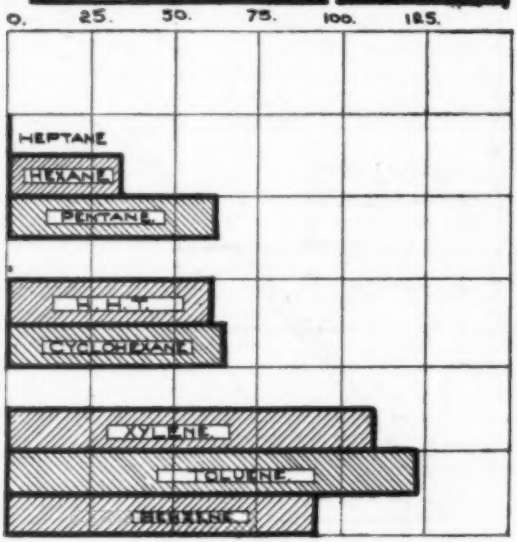


FIG. 12.

Fig. 12 is a diagram giving the observed " benzol values " of the chief hydrocarbons bodies, which, in most various proportions, go to form the different petrols of commerce. It is seen that while the Naphthenes and the Aromatics vary comparatively slightly among themselves, the difference, as regards detonation, between the three paraffins (Heptane, Hexane and Pentane) is very great. Naturally, there is a very little Pentane (since it boils at 36° C.) in motor spirits, so that the average value for the paraffins in petrol is likely to be low.

By measuring in a variable compression engine the detonation point for various petrols of which the aromatic and naphthene content is approximately known, it is possible to determine the average "benzol value" of the remainder. This remainder will consist mostly of paraffins, and probably will contain a small proportion of olefines, or unsaturated hydrocarbons. For nearly all petrols the olefines may, however, be neglected.

In Fig. 13 is shown the average "benzol values" of the three main types of hydrocarbon for an ordinary first-grade motor spirit.

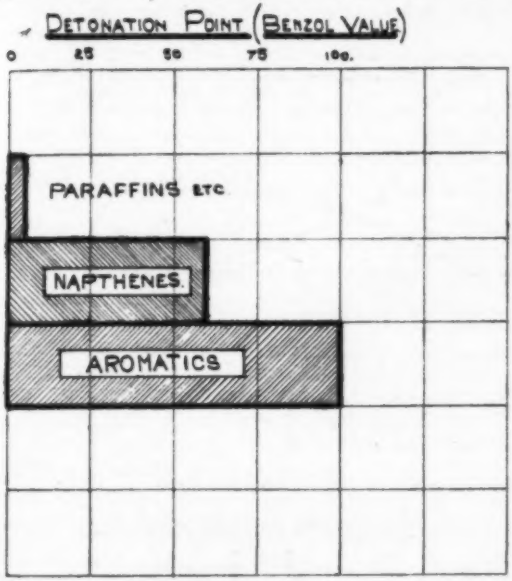


FIG. 13.

It is seen that the naphthenes are more than half as effective as the aromatics in suppressing detonation if mixed with the average paraffins occurring in motor spirits. That is to say, that the detonation point of a petrol containing 30 per cent. aromatics, and no naphthenes, will be very nearly the same as a fuel of similar distillation range but containing 50 per cent. naphthenes and no aromatics.

VOLATILITY AND DISTRIBUTION.

While tests with single cylinder engines show that volatility may vary between wide limits and no difference in power results,

nevertheless, where several cylinders of an engine are fed from one carburettor, it is usually impossible to design the manifold truly symmetrical so that a separation between the air and liquid particles of fuel occurs. As the result of this separation in the induction pipe, the mixture strength varies between the different cylinders. Now, if the average mixture is rich the variations will make little difference to the power obtained.

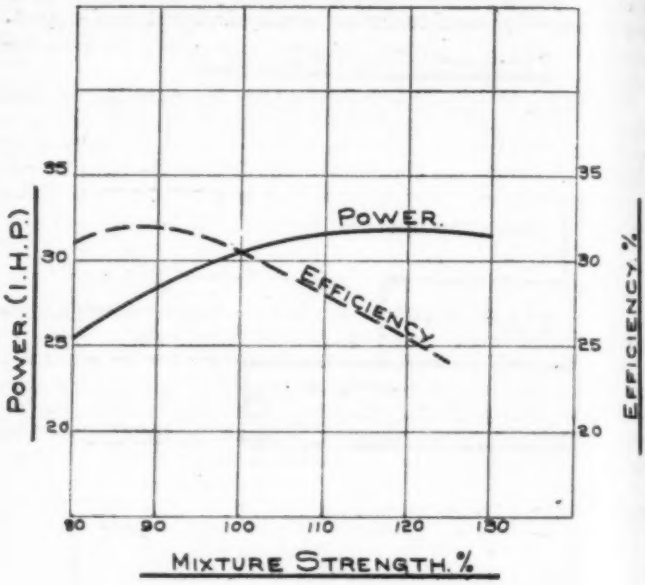


FIG. 14.

Fig. 14 shows the observed relations of both power and efficiency to mixture strength. From this diagram it is seen that the power is nearly unaffected by changes in mixture strength with rich mixtures. When, however, the mixture is weak, a slight variation in its strength causes considerable change in power. Since the best efficiency can only be obtained with weak mixtures, it is clear that equal distribution is most desirable so that each cylinder can work with the most advantageous mixture strength, having regard to both power and economy.

It is found by experiment that the more volatile the fuel the more equal the distribution in a multi-cylinder engine. With a more volatile fuel a larger proportion is evaporated before it enters the

branches of the manifold, and the variation in mixture strength as between cylinders is proportionally less. Since the latent heats of the various hydrocarbons in petrol are roughly the same, it is clear that the depression in temperature of the mixture in the induction pipe below that of the incoming air gives a measure of the fuel evaporated up to the point where the temperature is taken, and the fall in temperature may therefore be considered as a direct indication of the effective volatility from the standpoint of distribution. It is found that with a fuel of low average boiling point, as shown by the distillation curve, the temperature fall in the induction pipe is great and *vice versa*.

With a fuel of high average boiling point the incoming air must be raised to a higher temperature in order to produce an equal degree of vaporisation in the induction pipe and equally good distribution. With the greater heat added to the charge, however, its specific volume is increased, and a less weight of oxygen is drawn into the cylinder with consequent diminution of power.

Volatility and Ease of Starting.

Though the vapour pressure of a fuel is a rough indication of its starting qualities, it is by no means a direct measure.

As we have already seen the mixture strength for inflammability of hydrocarbon vapours must be not less than about 80 per cent. of the complete combustion mixture. With the complete combustion mixture the partial pressure, or vapour pressure, exerted by the fuel varies greatly for different substances.

Minimum Vapour Pressures for Complete Combustion in Air at 760 m.m.

	Vap. Press. m.m.		Mol. Wt.
Octane	12·5	HG	114
Heptane	14·3	,,	100
Hexane	16·5	,,	86
Cyclohexane	17·4	,,	84
Benzene	20·7	,,	78
Ethyl alchl.	50	,,	46

Fig. 15.

Fig. 15 gives these values for various typical bodies when mixed with air at normal atmospheric pressure 760 m.m Hg. These may be termed minimum vapour pressures for combustion. It may be observed that, for the paraffins, the minimum vapour pressure is inversely proportional to the molecular weight.

For actual petrols still less is the vapour pressure a measure of "startability." With nearly all petrols the full vapour pressure is developed only when at least 3 per cent. of the volume of the

vessel is occupied with the liquid. In a motor-car engine starting is required with perhaps one-thirtieth part of this quantity of fuel, and even so the ratio of fuel to air if the liquid were all vaporised would be nine times richer than the normal running mixture. The "startability" of a petrol in a cold engine (by means of flooding the carburettor) may be taken as a function of the volatility or mean boiling point of the first 10 per cent. to 20 per cent. of distillation, but it certainly bears no direct relation either to the vapour pressure of the fuel, or to its flash point or initial boiling point.

Final Boiling Point and Oil Dilution.

Just as in the matter of volatility (for good distribution and for easy starting) so also as regards Final Boiling Point (for safety in lubrication) it is impossible to give constants which will stand for all engines and under any service. It is known, however, that in order to avoid trouble under certain conditions due to condensed fractions of fuel in the cylinder diluting unduly the lubricating oil in the crank chamber, it is necessary that the final boiling shall not exceed 220° C.

With a higher final boiling point not only does much more condensate pass down to the crank chamber, but owing to that condensate having a lower vapour pressure, it is less easily evaporated at the temperature of the crankcase, with the result that when equilibrium is reached the proportion of condensate to lubricating oil is greater.

Conclusions.

The following conclusions are true only provided the detonation point is not exceeded with each fuel.

In a single-cylinder engine of fixed compression:

(1) All fuels are burned at practically the same efficiency, therefore:—Fuel economy (miles per gallon) is proportional to the heat value per gallon and nothing else.

(2) All fuels have practically the same total internal energy per unit volume of mixture with air, therefore:—Maximum power is the same for all petrols though it is about 5 per cent. greater for alcohol due to its excessive cooling effect on the cylinder charge.

In a single-cylinder engine of variable compression:

(1) Efficiency varies greatly with compression ratio, for example —Fuel economy (miles per gallon) increases 15 per cent. if the ratio is raised from 4 : 1 to 5 : 1.

(2) Power output varies slightly with compression ratio, for example :—Maximum power increases 8 per cent. if the ratio is raised from 4 : 1 to 5 : 1.

In a multi-cylinder engine of fixed compression :

(1) Fuel economy is proportional to the heat value per gallon, and also is a function of the mean volatility.

(2) Maximum power is practically constant for all fuels (except the alcohols). It depends very little *directly* on volatility, though it is greatly reduced by the external heating which may be applied to the mixture to gain economy with a fuel of low mean volatility, i.e., high average boiling point.

(3) Ease of starting from cold in any engine appears to depend on the mean boiling point of a certain constant proportion of the fuel at the lower end of the distillation curve.

The constant is nearly inversely proportional to the quantity of fuel which is taken into the cylinder, either by "flooding" or "doping," in terms of the quantity required for normal running. That is, if the mixture is enriched by five times for starting from cold, then it is the mean volatility of the first fifth of the fuel that determines the minimum temperature from which starting is possible.

(4) Final boiling of petrol for road vehicle engines should not exceed 220° C., and under certain conditions there appears to be an advantage in limiting this temperature to 200° C., or even less where bearings are highly loaded as in air-craft engines.

(5) *Fuel Composition.—For road vehicle engines* the petrol should contain the maximum of *aromatics* (having regard to the requirements for Starting, Distribution and Oil Dilution). The aromatics give the highest useful compression ratio, and they have the highest heat value per gallon or per pint.

For aircraft engines the fuel should contain the maximum of *naphthenes* (having regard to Starting, etc.). The naphthenes may be used at fairly high compressions without detonation. Their heat value per lb. is much higher than that of the aromatics, and is nearly as high as that of the paraffins. The paraffins, of course, cannot be used with a high compression, or, therefore, with good economy.

It is of perhaps rather more than academic interest to note, that for a present-day aeroplane, starting with all the fuel it could lift, the longest possible flight would be made with Cyclohexane.

Fuel.	Heat value.	
	B.T.U. lb.	B.T.U. pint.
Hexane	19,390	16,600
Cyclohexane	18,940	18,600
Benzene	17,460	19,300

Fuel.	Consumption.	
	H.U.C. lb.	H.U.C. pint.
Hexane	·405	·473
Cyclohexane	·385	·392
Benzene	·392	·355

FIG. 16.

Fig. 16 gives the calorific values of Hexane (a paraffin), Cyclohexane (a naphthene) and Benzene (an aromatic); also the minimum its highest useful compression in the variable compression single-cylinder testing engine, which has been referred to above.

CORRESPONDENCE.

RE "WORKING OF PETROLEUM BY MEANS OF SHAFTS AND GALLERIES."*

To the Editor,

THE JOURNAL OF THE INSTITUTION OF PETROLEUM TECHNOLOGISTS,

5, St. John Street, Adelphi, W.C. 2.

SIR,—Due to the writer having been travelling abroad at the time the paper was read and to his not having received the Journal forwarded on to him until quite recently, it is somewhat long after the delivery and publication in the Journal of M. Paul de Chambrier's most fascinating and interesting paper on the "Working of Petroleum by means of Shafts and Galleries," to offer any contribution to the subject, but it may interest some members of the Institute, if, in corroboration of M. Chambrier's postulate that

* *Journ. Inst. Petr. Techn.*, vii., pp. 178-205, July, 1921.

much more oil is left in a petroliferous stratum, after it is supposed to be pumped dry, than has ever been extracted by boring methods, the following history of a phase in the development of the Burmese oilfields is recounted.

In 1905 the position of the Yenangyaung Oilfields was that the Burmah Oil Company owned a huge majority of the Twinzah or native reserved oil well sites in the two Reserves of Twingone and Beme, each being between about 300 to 350 acres in extent, and, at the same time, held the entire area (called the Khodaung Block) intervening between the two Reserves.

Geologically, the Khodaung Block occupies a large part of the apical area of the dome. The two Reserves are about one mile apart. From 1908 onwards competitors began to acquire well sites in the two Reserves and, in self protection, in order to get even part of its just proportion of the oil in the Reserves, the Burmah Oil Company were compelled to drill on the well sites owned by it, some five wells to every one of its competitors. While doing this, the Khodaung Block was naturally neglected, partly, because the Reserves called for such a large employment of staff and plant, and partly because it was expected that, in the major part of the Khodaung Block even the intensity of the development in the Reserves would not be likely to drain the oil from the Khodaung Block to any great extent. This was not an illogical expectation in the light of the theories at the time advanced as to the maximum area likely to be drained by each individual well.

Somewhere about 1915 or 1916, when all the operators in the two Reserves had deserted the upper sands as being exhausted and had taken down their wells to a considerable depth, the Burmah Oil Company started to draw on their expected reserves in the upper oil sands in the Khodaung Block. To the dismay of the Company the first few wells drilled down to the upper sands appeared to be practically "dry," though they gave a little gas. Various theories were advanced for this disappointment, but the writer expressed the opinion that the failure to obtain oil from these Khodaung wells to anything like the average quantity naturally expected from sites, equally as good from a geological standpoint as the older exhausted wells in the Reserves, was not due to the complete drainage by the old wells of the ground between the two Reserves, but to exhaustion of the gas pressure throughout the whole area. The suggestion was then made that one method of obtaining some of the oil which, almost certainly, was retained in these upper sands in the Khodaung Block would be by an attempt to revive the pristine gas pressure, which had been lost by its migration from beneath the Khodaung Block to the numerous vents in the intensively drilled Reserves. It was suggested that this revival might be accomplished by forcing compressed air down

certain strongly capped boreholes, drilled through to the bottom of the oil sand which appeared to be dry, while other boreholes, carefully selected and so situated in relation to the compressed air boreholes as to afford some probability that the compressed air would travel through the sand to them, were to be left uncapped and open to allow the compressed air to flow out oil from the uncapped wells.

The writer has often thought and occasionally said that the day would come when some method of mining by shafts and galleries would be adopted to recover the large percentage of crude oil which was generally known to have been inextractable by the drilling of wells, from the so-called exhausted oil sands, but the writer did not expect that it would be so soon attempted and made successful, nor did he realise that the recovery of the oil by "oozings" from the beds would be so great, but rather anticipated that the sands would have to be treated in some such manner as oil shales are.

In the Yenangyaung field of Burma it would appear that there should be a vast quantity of oil recoverable from the shallow sands by means of "galleries"; the Burmese have for centuries past sunk innumerable "shafts" but, so far as the writer knows, have not attempted "galleries." In the northern blocks small quantities of a heavy oil were obtained by very shallow drilled wells from a sand, which was proved by geological mapping to outcrop in the centre of the dome, thus showing that many years of exposure of the sand at its outcrop had not resulted in the exhaustion of the same sand down the dip.

The Yenangyaung oilfield, with its deep gullies cutting down into the almost horizontal strata of the main plateau, should be an ideal place for following up the experiments of Pechelbronn, and the Burmese of the oilfields are, or were, experienced in mining for—as distinguished from drilling for—oil; but the comparative softness of the oil-bearing series may make the timbering difficult and mining somewhat dangerous. If mining by "shafts and galleries" at Yenangyaung could be made a success, it would give a new lease of life to this field, the oldest British-owned oilfield and probably the oldest field (where oil was obtained, by "shafts" not merely from shallow pits and seepages) in the world.—Yours faithfully,

BASIL F. N. MACRORIE.

REVIEWS

"A Treatise on Petroleum." By Sir Boverton Redwood, Bart. Charles Griffin and Co., Ltd. 3 vols. Price, £5 5s.

It would be difficult to attempt any review on orthodox lines of Redwood's *Treatise on Petroleum* for any ordinary journal, so extensive is the ground covered. For the Journal of the Institution of Petroleum Technologists it is altogether unnecessary, for hardly a member of the Institution does not use "Redwood" as his standard work of reference, and its contents are familiar to all.

The Third Edition was published in 1913 and it is a striking testimony to the value of the work that, by December, 1916, the publisher had to intimate to Sir Boverton that the work of revision for another edition must be put in hand. When this call came Sir Boverton was almost overwhelmed with official duties in connection with the war, but the revision was nevertheless undertaken with that indefatigable energy which characterised him. The high cost of printing and the difficulties associated with book production at that period might well have deterred any publisher from undertaking the issue of a treatise running into three large volumes, and every credit must be given to Mr. F. J. Blight, of Messrs. Griffins, for deciding on a thorough revision under such difficult circumstances.

The deplorable loss which the industry sustained through the sudden death of Sir Boverton was widely recognised in the universal expressions of appreciation of his life work. Great as was the loss to the industry one realises, with the Fourth Edition before one, how fortunate it was that he was spared to see nearly all the revision work completed, and much ready for the printer. It fell ultimately to others to see the volumes through the press, and only those who were closely associated with this phase of its production can realise what the devotion of Mrs. A. Lloyd Eastlake meant to its successful issue.

One cannot even indicate the main revisions to which the work has been subjected. Amongst those who have dealt with various sections we find the names of practically all the members of this Institution who we recognise as men of authority in their particular sphere of oil technology. It is unnecessary to say more as proof of the thoroughness of the revision. One great improvement has been in the pagination. In the previous editions paging has commenced afresh with each volume, but in the Fourth Edition the paging runs on through the three volumes, and this greatly simplifies indexing and reference.

Redwood's petroleum has been described by an influential oil journal as "indisputably the most comprehensive and complete treatise on Petroleum." *Nature* has described it as a perfect example of what a book of reference should be. We, as petroleum technologists, will fully endorse these opinions, and as members of the Institution founded by Sir Boverton Redwood, and from the association of so many of our members with its revision, may be pardoned if we have some feelings of personal pride in the production of the Fourth Edition of this monumental work. J. S. S. B.

"Distillation Principles and Processes." By Sidney Young, assisted by eminent collaborators. Macmillan. 40s. net.

Professor Young's well known treatise on Fractional Distillation was for many years the recognised treatise on the theory and practice of the separation of mixed liquids. During the war, with its gigantic demand on applied

chemistry, there was a famine, among other things, for Young's indispensable volume, and the few lucky individuals who possessed copies had to maintain a serious watch and ward over them.

Now at last the long expected revised edition has appeared, much amplified and with a far wider scope so far as those industries are concerned, which make extended use of fractionation. The distillation of acetone and *n*-butyl alcohol on the manufacturing scale has been written up by Dr. Reilly and the Hon. F. R. Henley, and these authors are also responsible for the chapter on Alcohol. J. Kewley, member of the Council for the Institution of Petroleum Technologists, has contributed the section on Petroleum. Dr. Butler discusses Coal Tar Distillation, whilst Glycerine and Essential Oils are handled by Col. Briggs and T. H. Durrens respectively.

It will be seen that Professor Young has very wisely confined himself to a thorough revision of the first edition and has placed the essentially technical sections of his work in the hands of experts who are familiar with the requirements, processes, and methods of their own particular industries.

The sections on Alcohol, Petroleum and Coal Tar will be of special interest to members of the Institution of Petroleum Technologists, and it is in the first industry that the separation of the two main components of a liquid mixture has been prosecuted with so much success, both on the theoretical and the practical side.

Mr. Kewley deals with the principles of intermittent and continuous stills and discusses the merits of a variety of methods of distilling crude oils. A full account is given of the working of the Trumble system and where possible fuel consumption is quoted. Dephlegmators, fractionating columns, distillate and residuum preheaters and condensers are discussed with ample diagrammatic illustrations, whilst all the operations from the topping of a heavy crude to the ultimate vacuum distillation of the lubricating oils are briefly and competently handled. One would have wished that the author had incorporated his own work on the fractionation of toluol-benzine from Borneo naphtha (a short description of which is given in Journal 27, Vol. 7, p. 209, 1921), but the exigencies of time and space presumably prevented this.

The book is admirably printed and got up, but attention may be called to a curious misprint on p. 138 where Dutton occurs for Dufton.

A. E. D.

"Oil Encyclopedia." By Marcel Mitzakis. Chapman & Hall. 21s. net.

The author of this work has undertaken a task which even a Committee of Experts might approach with some trepidation. Many volumes would be needed to contain complete references to all and every branch of the Oil Industry, and it is questionable whether the present work is entitled to so imposing and comprehensive a title as "Oil Encyclopedia."

The Geographical section of the book is elaborate and should be of assistance in locating producing oilfields and even in some cases small sections of fields, but in this respect undue prominence is perhaps given to detail at the expense of the Geological, Chemical, Refinery, Mechanical, Storage, Pipeline, etc. aspects, which receive only scant notice, and the data relating to Drilling and Drilling Systems are somewhat inadequate and at times rather misleading.

Had the author confined himself to one or two sections of the industry and dealt with it or them in detail the work would have a greater value, but in its present form it cannot be considered as complete as its title would indicate.

As a book of reference, within limits, the work will be a useful contribution to oilfield literature, and the author is to be commended for initiating a work which he or others may elaborate in course of time.

Bibliography

Compiled by W. J. Wilson, A.C.G.I., A.I.C.

1. Geological.

The Geology of the South American Republics in Relation to Petroleum Deposits.—D. White. *Oil Engineering and Finance* **1**, 269.

The Haynesville, La. Field.—W. W. Scott and B. K. Stroud. *La. Dept. of Conservation Bull.* 11. *Oil Engineering and Finance* **1**, 310.

The Huntingdon Beach Oilfield of California.—R. E. Collom. *Petr. Times* **7**, 332.

Geology of Persia applied to Oil Finding.—G. Howell. *Oil Engineering and Finance* **1**, 345, 505.

Oil Possibilities of Manitonlin Island. M. Y. Williams, *Can. Dept. Mines, Summary Report*, 1920, *Part D*, 26. *Chem. Abstr.* **16**, 542.

The Detection of Oil-bearing Strata in advance of the Drill.—W. Schropp. *Chem. und Tech. Zeit.*, March 1. *Oil Engineering and Finance* **1**, 470.

Pools or Beds, Streams of Oil ?—J. von G. Scale. *Petr. Times* **7**, 560.

Structure of the Glenn Formation, Oklahoma.—W. L. Goldston, Junr. *Bull. of the Amer. Assoc. of Petroleum Geologists. Oil Engineering and Finance* **1**, 481.

Surface Indications of Petroleum.—*Petr. Times* **7**, 578.

Petroleum Prospects in Alberta, Canada. *Oil News* **11**, 422.

Geology Applied to Oil Finding—India. G. Howell. *Oil Engineering and Finance* **1**, 511.

Water in Oil Districts.—H. Höfer. *Zeit. Int. Ver. Bobringen u. Bohntechniker*, Jan. 1. *Oil Engineering and Finance* **1**, 512.

Sub-Surface Conditions in Oil and Gas Fields.—*Oil Engineering and Finance* **1**, 548.

Petroleum Theory and Practice.—K. Friedl. *Chem. und Tech. Zeit.*, March 1. *Oil Engineering and Finance* **1**, 547.

The Oil Strata of Arkansas.—*Oil Engineering and Finance* **1**, 569.

The Tehuatepec Region of Mexico.—G. Howell. *Oil Engineering and Finance* **1**, 571.

The Anticlinal Structure and the Position of Crude Oil in it.—J. von G. Scale. *Petr. Times* **7**, 635.

Petroleum Investigations in Jugo-Slavia.—V. J. Vinda. *Petr. Times* **7** 659.

The Oil Pools of Warren Co., Kentucky.—*Ky. Geol. Surv.* [6], **6**, 103.

PETROLEUM RESOURCES OF CALIFORNIA.—L. V. Leck. *Cal. State Min. Bur. Bull.* 89.

GEOLOGIC STRUCTURE AND OIL AND GAS PROSPECTS OF A PART OF JEFFERSON CO., OKLAHOMA.—H. M. Robinson. *U.S. Geol. Surv. Bull.* 726F.

SOLITARIO UPLIFT, TEXAS.—S. Powers. *Bull. Geol. Soc. Amer.* **32**, 417.

THE CIEROO ANTICLINAL BOW OIL FIELD OF CALIFORNIA.—*Engineering and Mining Journal* **113**, 409.

GEOLOGY AND PETROLEUM DEPOSITS OF THE SOUTHERN DISTRICT OF LOWER CALIFORNIA.—M. Bustamento. *Bol. Petroleo.* **9**, 469. *Chem. Abstr.* **16**, 1199.

ARE STRUCTURES ESSENTIAL TO THE PRESENCE OF CRUDE OIL DEPOSITS?—J. von G. Scale. *Petr. Times* **7**, 715.

ESTIMATION OF PETROLEUM RESERVES.—A. C. Veatch. *Econ. Geol.* **47**, 132.

MINERALS IN ARKANSAS.—Arkansas Bur. Mines, 1922.

ADMINISTRATIVE REPORT OF THE STATE GEOLOGIST, TENNESSEE, 1920.—W. A. Nelson. *Tennessee Geol. Surv.*

2. GEOGRAPHICAL.

PRELIMINARY SUMMARY OF PRODUCTION BY STATES OF PETROLEUM IN U.S. FOR 1921.—*Oil Engineering and Finance* **1**, 274.

FEDERAL TAXATION OF THE PETROLEUM INDUSTRY.—N. White. *Oil Engineering and Finance* **1**, 280.

LOUISIANA OIL ANALYSIS.—U. S. Bureau Mines. *Oil Engineering and Finance* **1**, 294.

THE MONTANA FIELD.—*Oil Engineering and Finance* **1**, 297.

DETAIL OF MISCELLANEOUS OILS PRODUCED IN U.S. DURING 1921.—U.S. Bureau Mines. *Oil Engineering and Finance* **1**, 300.

PETROLEUM INDUSTRY OF POLAND.—*Chamber of Commerce Journal. Oil Engineering and Finance* **1**, 317.

ROUMANIAN OIL POSITION.—*Moniteur du Pétrole Roumain*, Feb. 25. *Oil Engineering and Finance* **1**, 323. *Petr. Times* **7**, 368.

PETROLEUM IMPORTS INTO THE UNITED KINGDOM.—(Corrected details for 1921). *Petr. Times* **7**, 291. *Oil News* **11**, 220.

MACKENZIE RIVER OILFIELDS.—F. H. Kitto. *Petr. Times* **7**, 296.

AMERICA'S PETROLEUM INDUSTRY.—M. Wilson. *Petr. Times* **7**, 328.

RUSSIA'S PETROLEUM INDUSTRY.—*Petr. Times* **7**, 364.

AMERICAN AND FOREIGN OIL POSSIBILITIES.—R. Arnold. *Am. Inst. Min. and Met. Engineers. Petr. Times* **7**, 379.

OIL IN LATIN AMERICA.—*Oil News* **11**, 232.

NEW PETROLEUM LAW OF PERU.—*Oil News* **11**, 233.

MEXICAN OIL INDUSTRY, 1921.—Petroleum Department of the Mexican Government. *Oil News* **11**, 243.

LATEST LIGHT ON THE MADAGASCAR OILFIELDS.—*Oil News* **11**, 264.

THE ALEXANDER "GASSER."—H. A. Matier. *Oil News* **11**, 246.

PRODUCTION OF MINERAL OIL IN THE DUTCH EAST INDIES.—*U.S. Commerce Repts.*, January, p. 24.

NYASALAND IMPORT DUTIES.—*U.S. Commerce Repts.*, January, p. 47.

THE OIL INDUSTRY IN RUSSIA.—*U.S. Commerce Repts.*, January, p. 87.

RECENT DEVELOPMENTS IN THE TAMPICO OIL FIELDS.—*U.S. Commerce Repts.*, January, p. 89.

A FRENCH IMPORT DUTY ON BENZENE.—*U.S. Commerce Repts.*, January, p. 157.

PRODUCTION OF CRUDE OIL IN ROUMANIA.—*U.S. Commerce Repts.*, January, p. 194.

EXPORTS OF CRUDE PETROLEUM FROM THE U.S. DURING DECEMBER, 1921.—*U.S. Commerce Repts.*, January, p. 267.

STATUS OF THE PETROLEUM QUESTION IN ARGENTINA.—*U.S. Commerce Repts.*, January, p. 268.

PRODUCTION OF PETROLEUM IN ARGENTINA DURING 1921.—*U.S. Commerce Repts.*, January, p. 270.

IMPORT DUTY ON GASOLINE IN BRAZIL.—*U.S. Commerce Repts.*, Jan., p. 281.

FRANCE IMPORT DUTIES.—*U.S. Commerce Repts.*, January, p. 281.

OIL PROSPECTS IN PERU.—*Petr. Times* **7**, 419.

THE RUSSIAN PETROLEUM INDUSTRY.—The Lamp. *Petr. World* **19**, 137.

REVIEW OF RUSSIAN OIL POSITION.—*U.S. Commerce Repts. Petr. World* **19**, 144.

OIL AND GAS PROSPECTS IN AUSTRALIA.—*Petr. World* **19**, 156.

CANADIAN OIL EXPLORATION.—G. G. Ommaney. *Petr. World* **19**, 167.

PETROLEUM AND GAS IN CALIFORNIA IN 1921.—R. E. Collom. *California State Mining Bureau Rept. Petr. World* **19**, 169.

PROPERTIES OF TYPICAL CRUDE OILS FROM THE PRODUCING FIELDS OF KANSAS.—E. W. Dean, M. B. Cooke, & A. D. Bauer. *U.S. Bureau Mines Rept. Investigations* 2322. *Oil Engineering and Finance* **1**, 355. *Int. Petr. Reporter* **1**, (10), 18.

VISCOSITIES AND POUR TESTS OF TYPICAL CRUDE OILS FROM THE EASTERN AND ROCKY MOUNTAIN PRODUCING FIELDS OF THE U.S.—E. W. Dean, A. D. Bauer & W. B. Lerch. *U.S. Bur. Mines Repts. Investigations*, 2290. *Chem. Abstr.* **16**, 638. *Oil Engineering and Finance* **1**, 464.

ARGENTINE OIL SITUATION.—*London and River Plate Bank Monthly Review Oil News* **11**, 354.

FRANCE AND ITS PETROLEUM POLICY.—*Petr. Times* **7**, 469.

PETROLEUM IN NEW GUINEA.—F. H. M. Macintosh. *Chem. Eng. and Min. Rev. Petr. Times* **7**, 476.

U.S. HAS ONLY TWENTY YEARS' SUPPLY.—*Int. Petr. Reporter* **1**, (4), 11.

HAYNESVILLE CRUDE TESTED.—*Int. Petr. Reporter* **1**, (10), 45.

WHY CALIFORNIA DEEP WELLS ARE PROFITABLE.—B. V. Ellzey. *Oil Weekly* **24**, (4), 62.

PETROLEUM IN FRANCE.—*Petr. Times* **7**, 503.

THE POSSIBLE ECONOMIC DEVELOPMENT OF HOME SUPPLIES OF FUEL OIL.—J. S. S. Brame. *Petr. Times* **7**, 507.

ARGENTINE PETROLEUM INDUSTRY.—*U.S. Commerce Repts.*, p. 323.

PETROLEUM FIELD IN THE PROVINCE OF ANTOFAGASTA, CHILE.—*U.S. Commerce Repts.*, p. 384.

MONOPOLY BY THE GOVERNMENT OF SWITZERLAND ON BENZINE AND "PETROLE" ENDED.—*U.S. Commerce Repts.*, p. 475.

BOLIVIA PETROLEUM CONCESSIONS.—*U.S. Commerce Repts.*, p. 514.

NEW PERUVIAN PETROLEUM LAW.—*U.S. Commerce Repts.*, p. 514.

PETROLEUM DEPOSITS IN SOUTHERN INDIA.—H. W. Perry. *Oil Engineering and Finance* **1**, 477.

THE GERMAN MOTOR-FUEL PROBLEM.—W. Ostwald. *Brennstoff Chem.* **2**, 321. *Chem. Abstr.* **16**, 816.

PETROLEUM IN ITALY.—*Petr. Times* **6**, 771. *Chem. Abstr.* **16**, 824.

THE OILFIELDS OF BURMA AND INDIA.—British Indian Crafts. *Petr. Times* **7**, 595.

ARGENTINA MONTHLY REVIEW. London and River Plate Bank. *Petr. World* **24**, 193.

OIL INDICATIONS AT LAKE ALBERT.—*Oil Engineering and Finance* **1**, 512.

U.S. BASIS OF ROYALTIES.—*Oil Engineering and Finance* **1**, 516.

OIL AND COAL RESOURCES OF WYOMING.—C. F. Bowen and others. U.S. Geol. Surv. *Oil Engineering and Finance* **1**, 552.

PETROLEUM OF ALBERTA.—*J. Soc. Chem. Ind.* **41**, 176R.

ANALYSIS OF CZECHOSLOVAKIAN PETROLEUM.—F. Schulz. *Petroleum* **18**, 321. *J. Soc. Chem. Ind.* **41**, 281A.

HARDSTOFT CRUDE OIL, REFINERY TEST.—*Oil News* **11**, 453. *Petr. Times* **7**, 613. *Oil Engineering and Finance* **1**, 570.

THE BAKU OIL INDUSTRY.—*Oil Engineering and Finance* **1**, 565.

THE NATURAL GAS RESOURCES OF ALBERTA.—*Petr. Times* **7**, 654.

PETROLEUM OF MEXICO.—J. B. Rathbun. *Petr. Age* **9** (8), 37.

SEARCHING FOR PETROLEUM IN AUSTRALIA AND NEW GUINEA.—*U.S. Commerce Reports*, p. 573.

OIL INDUSTRY IN POLAND.—*U.S. Commerce Reports*, p. 573.

The Petroleum Fields of Mendoza, Neuquen.—*U.S. Commerce Reports*, p. 573.

U.S. Petroleum Export Trade in 1921.—*U.S. Commerce Reports*, p. 638.

Record Shallow Well in the Tampico Oil Fields.—*U.S. Commerce Reports*, p. 640.

Exploration of Bolivian Oilfields.—*U.S. Commerce Reports*, p. 640.

Production of Crude Oil in Roumania during 1920 and 1921.—*U.S. Commerce Reports*, p. 700.

Petroleum Possibilities in Spain.—*U.S. Commerce Reports*, p. 701.

Ecuador Petroleum Concessions.—*U.S. Commerce Reports*, p. 762.

New Zealand Import Duties.—*U.S. Commerce Reports*, p. 778.

Properties of some Typical American Crude Oils.—E. W. Dean, M. B. Cooke & C. R. Bopp. U.S. Bur. Mines. *Oil Engineering and Finance* **1**, 613.

Oil Ventures in Venezuela.—*Oil News* **11**, 516.

The Oil Industry of the Future.—L. C. Uren. *The Record* **3** (April), 3.

The Roumanian Petroleum Industry.—H. Rotton. *Rig and Reel Mag.* (March), 10.

Review of the Petroleum Possibilities and Developments.—State of Utah. *Railway Red Book* **39**, 513.

Oil Exploration.—A Gray. *Canad. Min. Jour.* **43**, 68.

Oil Prospects in West Africa being Tested Out.—*Oil Trade Jour.* **13** (4), 56.

Map of Deaner and Lyons-Quinn Oil Fields, Oklahoma.—U.S. Bur. Mines.

Gasolines from Californian Crude.—*Oil Engineering and Finance* **1**, 596.

U.S. Production of Petroleum by Fields.—*Oil Engineering and Finance* **1**, 600.

U.S. Imports and Exports of Mineral Crude Oil.—*Oil Engineering and Finance* **1**, 600.

3. Drilling and Field Operations.

Screen Pipe in Oil Wells.—E. W. Wagy. *U.S. Bur. Mines Tech. Paper* 247. *Petr. Times* **7**, 329, 381, 453.

A New Development in Rotary Machines.—*Petr. Times* **7**, 335.

Pushing Oil Production by Gas.—A. W. Ambrose. U.S. Bur. Mines. *Oil News* **11**, 137.

Diamond Drilling for Oil in Mexico.—F. A. Edson. *Oil Engineering and Finance* **1**, 348.

The Percussion System applied to Drilling.—G. Howell.—*Oil Engineering and Finance* **1**, 352, 507.

EXTINGUISHING AN OIL-WELL FIRE IN MEXICO.—A. B. Clifford. Trans. Amer. Inst. Min. Eng. *Oil Engineering and Finance* **1**, 411.

LOW PRESSURE GAS FOR OILFIELD BOILERS.—G. S. Brewer, M. P. Yonker & C. E. Beecher. *Mid-Continent Oil and Gas Assoc. Year Book for* 1921. *Oil Engineering and Finance* **1**, 412, 431.

ON THE ESTIMATING OF PETROLEUM RESERVES.—E. H. De Golyer. Econ. Geology. *Oil News* **1**, 344, 372.

SUBTERRANEAN GAS FAILURE CAUSES LOSS OF PETROLEUM. *Int. Petr. Reporter* **1**, (6), 44.

PROBLEMS IN DEVELOPING PROSPECTS.—A. W. Ambrose. *Int. Petr. Reporter* **1** (7), 11.

LEAKS IN THE OIL FIELDS.—L. J. Pepperberg. *Oil Weekly* **24**, (4), 21.

ELECTRIC DRILLING EFFECTS TREMENDOUS SAVING.—B. V. Ellzey. *Oil Weekly* **24**, (4), 34.

DRILLING COSTS IN VARIOUS FIELDS.—*Oil Weekly* **24**, (4), 54.

REVERSE RETURN SYSTEM OF ROTARY DRILLING.—J. R. Suman. *Oil Weekly* **24**, (4), 42.

NEW DEVICE FOR FLOWING WELLS BEING USED IN CALIFORNIA.—*Oil Weekly* **24**, (4), 66.

PROSPECTING FOR OIL WITH DIAMOND DRILL.—J. S. Mitchell. *Oil Weekly* **24**, (4), 50.

OIL LOSSES DUE TO DRILLING DELAYS.—*Oil and Engineering Finance* **1**, 470.

DELAY IN FIELD DEVELOPMENT.—U.S. Bur. Mines. *Oil News* **11**, 408.

A NEW METHOD OF PRODUCING CRUDE OIL IN KENTUCKY. W. R. Jillson. *Ky. Geol. Surv.* (6), **6**, 149.

CONDITIONING A WELL FOR OIL PRODUCTION.—H. F. Kessal. *Ind. Australia* **66**, 1135.

MEXICAN OIL PRODUCTION—SOME BIG WELLS.—C. W. Pardo. *Texaco Star* **9** (Feb. 5).

NOTES ON THE USE OF OIL INSTEAD OF WATER OR MUD FLUID AS A MIXING FLUID IN DRILLING.—*Cal. State Oil and Gas Supervisor Ann. Report* **7** (Dec.).

A NEW TYPE OF POWER PLANT FOR DRILLING.—*Petr. World* (Los Angeles) **7** (Feb.), 36.

A METHOD FOR LOOSENING FROZEN CASING OR DRILL PIPE WITH OIL.—W. W. Copp. *Cal. State Oil and Gas Supervisor Ann. Report* **7** (Dec.).

A HOLE DEEP AND DRY.—*Standard Oil Bull.* **9** (Feb. 14).

PREMATURE EXPLOSIONS OF NITROGLYCERIN IN OIL-WELL DRILLING OPERATIONS.—G. W. Porter. *J. Ind. Eng. Chem.* **14**, 212.

SHOOTING WELLS IN TEXAS.—J. Hutcheson. *The Record* **3** (April), 14.

METHOD USED BY CHANSLOR-CANFIELD CO. IN DRILLING WELLS.—F. W. Ziegler. *Cal. State Oil and Gas Supervisor Ann. Report* **7** (Jan.).

Method of Lubricating Drill Collars to Protect Casing from Wear.—W. W. Copp. *Cal. State Oil and Gas Supervisor Ann. Report* **7** (Jan.).

Standard Using Pumping Motors at Elk Hills.—*Oil Weekly* **25**, (2), 8.

Standardising Equipment in California.—B. V. Ellzey. *Oil Weekly* **25**, (2), 9.

Patents.

Gravity Separation of Oil and Gas.—D. G. Lorraine. U.S. Pat. 1,396,860. *Chem. Abstr.* **16**, 643.

Well Drilling without Casing.—U.S. Pat. 1,401,488. *Oil Engineering and Finance* **1**, 599.

Pumping Mechanism.—U.S. Pat. 1,401,440. *Oil Engineering and Finance* **1**, 600.

Well Capping Device.—G. W. Brown. U.S. Pat. 1,409,660.

Spudding Jack.—S. Bullum and W. O. Maxwell. U.S. Pat. 1,409,438.

Rotary Mud.—L. S. Copelin. U.S. Pat. 1,411,164.

Earth Boring Apparatus.—J. H. Herman. U.S. Pat. 1,410,674.

Rotary Boring Drill.—F. L. O. Wadsworth. U.S. Pat. 1,408,549.

Oil Well Pump.—T. J. Barger. U.S. Pat. 1,408,852-3.

Spudding Shoe.—B. T. Holman. U.S. Pat. 1,409,177.

Method and Apparatus for Removing Water from Gas Wells.—G. A. Kobel. U.S. Pat. 1,409,346.

Sealing Device for Wells.—E. N. Miller. U.S. Pat. 1,411,057.

Method of Cleaning Oil Wells.—W. F. Muehl. U.S. Pat. 1,410,827.

Fishing Tool.—G. A. Robinson. U.S. Pat. 1,409,197.

Oil Well Machinery.—J. D. Russ. U.S. Pat. 1,409,066-7.

Sucker-Rod Trap.—R. H. Stageman. U.S. Pat. 1,409,424.

Apparatus for Elevating Oil.—W. R. Stuck. U.S. Pat. 1,410,228.

4. Pipe Lines, Transport and Storage.

Recommended Practice for Concrete Oil Tank Construction.—*Oil News* **11**, 134.

Concrete Tanks for Oil Storage.—G. A. Smith. *Proc. Am. Concrete Inst.* **17**, 22. *Chem. Abstr.* **16**, 474.

Tank Car Measurements.—A. P. Bjerregaard. *Oil and Gas J.* **20**, (26), 74. *Chem. Abstr.* **16**, 641.

Concrete Tank Construction.—E. C. Swanson. *Eng. World* **18**, 91. *Chem. Abstr.* **16**, 998.

STEEL STORAGE TANKS FOR CRUDE AND REFINED PETROLEUM.—W. Samaan. *Atlantic Connecting Rod* **14**, Feb. 15.

PAINTS FOR LIGHT OIL STORAGE TANKS AND A NOTE ON A SPRAY EQUIPMENT.—H. A. Gardner. *Paint Mfrs. Assoc. of U.S. Circ.* 131. *Chem. Abstr.* **16**, 1325.

SCIENCE GIVES PAINT TIPS.—J. P. Ormsby. *Petr. Age* **9**, (7), 62.

NEW 55,000 BARREL TANK DECK CREATES WIDE INTEREST.—*Petr. World* (Los Angeles) **7** (Feb.), 32.

EVAPORATION LOSS OF PETROLEUM IN THE MID-CONTINENT FIELD.—J. H. Wiggins. *U.S. Bur. Mines Bull.* 200.

SPECIFICATIONS AND TOLERANCES FOR LIQUID MEASURING DEVICES.—R. W. Smith. *U.S. Bur. of Standards Miscell. Publ.* 48.

PATENTS.

FIRE-EXTINGUISHERS.—H. S. Monk. U.S. Pat. 1,393,236-7. *Chem. Abstr.* **16**, 472.

STORAGE OF STABLE MOBILE FUEL MIXTURES UNDER WATER.—L. W. Bates. U.S. Pat. 1,394,060. *Chem. Abstr.* **16**, 486.

STORAGE OF HIGHLY INFLAMMABLE LIQUIDS.—J. Muchka. Brit. Pat. 153,915. *J. Soc. Chem. Ind.* **41**, 240A.

FIRE-EXTINGUISHING LIQUID.—B. I. Corson. U.S. Pat. 1,401,240. *Chem. Abstr.* **16**, 996.

FIRE-EXTINGUISHERS.—G. J. Money. Brit. Pat. 170,390. *Chem. Abstr.* **16**, 1138.

OIL-CARRYING SHIP OR BARGE.—W. A. Ebson. U.S. Pat. 1,410,287.

CONTAINER FOR STORING LIQUIDS.—W. D. Rial. U.S. Pat. 1,408,829.

5. REFINERY TECHNIQUE.

PETROLEUM REFINING (SECOND EDITION).—A. Campbell. Charles Griffin and Co.

RECOVERY OF GASOLINE FROM STILL VAPOURS.—D. B. Dow. *Oil Engineering and Finance* **1**, 411.

EXPLOSION OF AGITATOR CHARGED WITH NAPHTHA.—W. Vernet and J. L. Klein. *Chem. and Met. Eng.* **26**, 4. *Chem. Abstr.* **16**, 647.

METHODS OF TREATING LUBRICATING OILS.—A. E. Peterson. *Oil Weekly* **24**, (4), 16.

THE PROFITABLE REFINING OF PETROLEUM.—H. L. De Bar. *Oil Weekly* **24**, (4), 138.

RELATIVE EFFICIENCY OF VARIOUS TYPES OF CONDENSING APPARATUS.—A. F. Brewer and F. A. Stivers. *Mech. Eng.* **43**, 672. *Chem. Abstr.* **16**, 663.

Recovery of Sulphuric Acid from the Waste Acid of Petroleum Refineries.—A. W. C. van Vooshout. *Chem. Weekblad* **19**, 115. *J. Soc. Chem. Ind.* **41**, 283A.

Treating Natural Gas Gasoline to Meet the "Doctor Test." D. B. Dow. *U.S. Bur. Mines Repts. Investigations* 2191.

Efficiency and Capacity of Fractionating Columns.—*Chem. and Met. Eng.* **26**, 729.

Corrosion of Petroleum Refining Equipment.—R. R. Matthews and P. A. Crosby. *Chem. and Met. Eng.* **26**, 735. *Petr. Times* **7**, 523.

Thermal Problems of Petroleum Refining.—L. A. Mekler, *Chem. and Met. Eng.* **26**, 774.

Patents.

Reclaiming used Lubricating Oils.—W. L. Jordan. U.S. Pat. 1,393,223. *Chem. Abstr.* **16**, 453.

Treating Mineral Oils with Chemicals in Jet Form.—A. B. Foster. U.S. Pat. 1,394,486. *Chem. Abstr.* **16**, 489.

Separating Oil and Water from Emulsions.—S. F. Alden and H. C. Eddy. U.S. Pat. 1,394,462. *Chem. Abstr.* **16**, 489.

Process of Refining Viscous Petroleum Oils.—R. W. Hanna. U.S. Pat. 1,404,389. *Chem. Abstr.* **16**, 1148.

Process for Clarifying and Improving the Colour of Petroleum Oils.—M. L. Chappell and M. M. Moore, Assrs. to Standard Oil Co., California. U.S. Pat. 1,404,374-5. *J. Soc. Chem. Ind.* **41**, 209A. *Chem. Abstr.* **16**, 1148.

Purification of Petroleum Oils.—J. J. Hood, Assr. to the Oil Refining Improvements Co. U.S. Pat. 1,404,293.

Manufacture of Aluminium Chloride (from Hydrocarbon Residues).—A. M. McAfee, Assr. to Gulf Refining Co. U.S. Pat. 1,405,734. *J. Soc. Chem. Ind.* **41**, 216A. *Chem. Abstr.* **16**, 1313.

Purifying Petroleum Hydrocarbons.—O. E. Bransky. U.S. Pat. 1,396,399. *Chem. Abstr.* **16**, 642.

Method for Producing Emulsoids.—E. E. Werner. U.S. Pat. 1,406,791. *J. Soc. Chem. Ind.* **41**, 240A.

Preparation of Substances which Solidify on Cooling (Paraffin Wax) from Oily Substances by Filtration and the use of Volatile Solvents.—F. Seidenschnur. Ger. Pat. 344,873. *J. Soc. Chem. Ind.* **41**, 245A.

Preparation of Lubricating and Cylinder Oils.—F. C. Thiele and C. Cordes. Brit. Pat. 154,895. *J. Soc. Chem. Ind.* **41**, 285A.

Method of Preparing Clay for the Bleaching of Petroleum Products.—C. W. Stratford. U.S. Pat. 1,408,655. *J. Soc. Chem. Ind.* **41**, 286A.

Method of Recovering Clay used in the Bleaching of Petroleum Products.—C. W. Stratford. U.S. Pat. 1,408,656. *J. Soc. Chem. Ind.* **41**, 286A.

FILTERING AND OIL-DECOLORISING EARTH.—R. G. Tellier. U.S. Pat. 1,402,112. *Chem. Abstr.* **16**, 978.

SULPHURIC ACID.—W. H. Simonson and O. Mantuis. Brit. Pat. 171,694. *Chem. Abstr.* **16**, 994.

TREATING RESIDUES OF PETROLEUM AND ALUMINIUM CHLORIDE REACTIONS.—L. Burgess. U.S. Pat. 1,401,113. *Chem. Abstr.* **16**, 1011.

PURIFYING PETROLEUM OILS WITH SULPHURIC ACID.—C. M. Alexander. U.S. Pat. 1,402,733. *Chem. Abstr.* **16**, 1011.

REVIVIFYING SPENT FULLER'S EARTH.—C. I. Robinson. U.S. Pat. 1,403,196. *Chem. Abstr.* **16**, 1011.

PURIFYING HYDROCARBONS.—M. Benson. Brit. Pat. 170,073. *Chem. Abstr.* **16**, 1148.

DESULPHURISING OIL.—J. C. Clancy. Can. Pat. 215,387, 215,380. *Chem. Abstr.* **16**, 1148.

SULPHUR FROM MINERAL OILS.—J. C. Clancy. Can. Pat. 215,386. *Chem. Abstr.* 1148, (**16**).

REFINING PETROLEUM DISTILLATES.—A. J. Paris, Junr. U.S. Pat. 1,405,156. *Chem. Abstr.* **16**, 1148.

DESULPHURISING PETROLEUM OILS.—J. J. Hood. U.S. Pat. 1,404,293-4. *Chem. Abstr.* **16**, 1148.

PRESSURE CONDENSATES FROM PETROLEUM VAPOURS.—A. J. Paris, Junr. U.S. Pat. 1,405,153-4. *Chem. Abstr.* **16**, 1149.

PURIFICATION OF MINERAL OIL AND ITS DISTILLATES WITH ACETONE, OR ITS HOMOLOGUES.—H. Rebs. Ger. Pat. 348,089. *J. Soc. Chem. Ind.* **41**, 321A.

(OIL REFINERY) SLUDGE TREATMENT.—F. Salathe, Assr. to Western Gas Construction Co. U.S. Pat. 1,409,590. *J. Soc. Chem. Ind.* **41**, 322A.

PURIFYING PARAFFIN OR SIMILAR HYDROCARBONS.—J. M. Treneer and C. S. Benjamin. U.S. Pat. 1,392,370.

RECOVERY OF OIL FROM JAPANESE ACID CLAY USED FOR PURIFICATION OF OIL.—S. Ueno. Jap. Pat. 37,465. *Chem. Abstr.* **16**, 1331.

6. NATURAL GAS.

RECENT DEVELOPMENTS IN THE METHODS FOR THE EXTRACTION OF GASOLINE FROM NATURAL GAS.—F. E. Hosmer and F. M. Seibert. *Petr. Times* **7**, 523.

CALIFORNIA AND ITS NATURAL GAS INDUSTRY.—California State Mining Bureau Bulletin. *Petr. Times* **7**, 584.

HELIUM IN NATURAL GAS.—H. B. Milner. *Nature* **109**, 112.

APPLICATION OF NATURAL GAS AND WASTE GAS FROM PETROLEUM STILLS.—Y. Tanaka. *J. Chem. Ind.* (*Japan*) **24**, 789. *Chem. Abstr.* **16**, 1309.

Extraction of Gasoline from Natural Gas.—F. M. Seibert and F. E. Hosmer. *Chem. and Met. Eng.* **28**, 735.

Natural Gases and their Application.—P. Damm. *Z. angew. Chem.* **35**, 121.

Patents.

Lampblack from Methane.—C. S. Bradley. U.S. Pat. 1,396,018. *Chem. Abstr.* **16**, 618.

Carbon Black.—B. W. Rumbarger. U.S. Pat. 1,401,737. *Chem. Abstr.* **16**, 995.

Carbon-black and Hydrochloric Acid from Natural Gas.—B. W. Rumbarger. U.S. Pat. 1,401,738. *Chem. Abstr.* **16**, 995.

Hydrogen from Hydrocarbons. J. C. Clancy. Can. Pat. 215,385. *Chem. Abstr.* **16**, 1136.

Hydrogen and Nitrogen Mixture.—J. C. Clancy. Can. Pat. 215,383. *Chem. Abstr.* **16**, 1137.

Carbon Products from Natural Gas.—I. Szarvasy and F. H. Bensel. U.S. Pat. 1,398,751. *Chem. Abstr.* **16**, 823.

7. Petrol and Other Motor Fuels.

The Character of Motor Gasoline in America.—A. D. Bauer and N. A. C. Smith. *U.S. Bur. Mines Repts. Investigations* 2328. *Oil News* **11**, 259. *Oil Engineering and Finance* **1**, 296. *Int. Petr. Reporter* **1**, (10), 47.

Physical Properties of Motor Fuels.—W. R. Ormandy and E. C. Craven. *Oil Engineering and Finance* **1**, 322. *J. Soc. Chem. Ind.* **41**, 96B.

An Unusual Type of Casinghead Gasoline.—C. E. Coates and B. Y. Tims. *J. Ind. Eng. Chem.* **14**, 219. *J. Soc. Chem. Ind.* **41**, 320A. *Chem. Abstr.* **16**, 1313.

Alcohol as a Motor Fuel in Cuba.—*U.S. Commerce Repts.*, Jan., p. 24.

Fuel Research Board, Second Memorandum on Fuel for Motor Transport.—H.M. Stationery Office, London.

The Combustion of Liquid Fuels in Motors, with Special Consideration of the Study of the Exhaust Gas.—F. Wehrmann. *Z. Elektrochem.* **27**, 379. E. Terres and F. Wehrmann. *Z. Elektrochem.* **27**, 423. *Chem. Abstr.* **16**, 478.

Natural Gas Gasoline in 1919.—E. G. Sievers. *U.S. Geol. Surv. Mineral Resources of U.S.*, 1919, *Pt. II.*, 519.

Vapour Tension of Natural Gas Gasoline.—D. B. Dow. *Oil Engineering and Finance* **1**, 410.

Calculation Table for Motor Fuel Mixtures.—W. Ostwald. *Chem. Zeit.* **45**, 897. *Chem. Abstr.* **16**, 632.

Utility of Benzene for Transport Purposes.—E. de Normanville. *Gas J.* **156**, 557. *Gas World* **75**, 463. *Chem. Abstr.* **16**, 636.

SHALE GASOLINE VERSUS PETROLEUM GASOLINE.—*Railroad Red Book* **38**, 868. *Chem. Abstr.* **16**, 641.

GASOLINE EFFICIENCY DOUBLED BY CHEMISTS.—*Int. Petr. Reporter* **1**, (6), 18.

NATURAL GASOLINE INDUSTRY GROWS.—A. V. Borque. *Oil Weekly* **24**, (4), 147.

DETONATION CHARACTERISTICS OF BLENDS OF AROMATIC AND PARAFFIN HYDROCARBONS.—T. Midgley, Junr., and T. A. Boyd. *Chem. and Met. Eng.* **26**, 735. *Petr. Times* **7**, 523.

POWER ALCOHOL: ITS PRODUCTION AND UTILISATION.—G. W. Monier Williams. Henry Froude and Hodder & Stoughton.

ALCOHOL AS FUEL. *U.S. Commerce Reports*, p. 382.

FUEL RESEARCH DEVELOPMENTS.—C. F. Kettering. *J. Soc. Autom. Eng.* **9**, 291. *Chem. Abstr.* **16**, 812.

MEASURING THE TRUE VOLATILITY OF MOTOR FUEL.—R. E. Wilson. *J. Soc. Autom. Eng.* **10**, 6, 17. *Chem. Abstr.* **16**, 814.

TETRALIN AS A FUEL FOR EXPLOSION MOTORS.—E. de Gramm. *Rev. prod. chim.* **24**, 729. *Chem. Abstr.* **16**, 815.

REQUIREMENTS OF MOTOR VEHICLE FUEL.—H. M. Crane. *Nat. Petroleum News* **13**, (50), 42.

A METHOD OF FRACTIONATING LIQUID MIXTURES AND ITS APPLICATION IN THE PREPARATION OF A DOMESTIC FUEL.—C. Mariller. *Compt. rend.* **173**, 1087. *Chem. Abstr.* **16**, 816.

POSSIBILITIES OF THE PLANT GROWTH OF THE MOIST TROPICS TO FURNISH MATERIALS FOR LIQUID FUEL.—H. N. Whitford. *J. Ind. Eng. Chem.* **14**, 151. *Chem. Abstr.* **16**, 816.

THE USE OF MIXED PETROL AND ALCOHOL. *Oil Engineering and Finance* **1**, 538.

THE "NATIONAL" MOTOR FUEL: MOTOR ALCOHOL.—M. Manfarand. *Bull. assoc. chim. sucr. dist.* **39**, 65. *Chem. Abstr.* **16**, 1001.

ALCOHOL FUEL IN PERNAMBUCO. *U.S. Commerce Reports*, p. 621. C. R. Cameron.

INDUSTRIAL AND POWER ALCOHOL.—R. C. Farmer. Sir Isaac Pitman and Sons, London.

ALCOHOL MOTOR FUEL RESEARCH: INTERIM REPORT OF THE ENGINEERING SUB-COMMITTEE OF THE EMPIRE MOTOR FUELS COMMITTEE OF THE IMPERIAL MOTOR TRANSPORT COUNCIL. *Petr. Times* **7**, 711. *Oil News* **11**, 502.

ALCOHOL MOTOR FUELS IN SOUTH AFRICA.—C. J. Pisar. *U.S. Commerce Reports*, p. 621.

GASOLINE SUBSTITUTES AND SYNTHETIC PRODUCTS.—E. Owen. *Oil Trade J.* **13**, (4), 13.

Patents.

Liquid Fuel.—C. C. D. Steele and H. B. Clifton. Brit. Pat. 174,712. *J. Soc. Chem. Ind.* **41**, 209A.

Liquid Fuel.—W. T. Schreiber, Assr. to U.S. Industrial Alcohol Co. U.S. Pat. 1,405,806. *J. Soc. Chem. Ind.* **41**, 209A.

Liquid Fuel.—M. C. Whitaker, Assr. to U.S. Industrial Alcohol Co. U.S. Pat. 1,405,809. *J. Soc. Chem. Ind.* **41**, 209A. *Chem. Abstr.* **16**, 1313.

Process of Producing Liquid Fuels.—W. T. Schreiber, Assr. to U.S. Industrial Alcohol Co. U.S. Pat. 1,405,805. *Chem. Abstr.* **16**, 1312.

Liquid Fuels.—Akt.-Ges. für Anilin-Fabrikation. Brit. Pat. 169,428. *Chem. Abstr.* **16**, 822.

Motor Fuel.—F. W. Rohrs. U.S. Pat. 1,399,227. *Chem. Abstr.* **16**, 822.

Internal-combustion Motor Fuel.—W. T. Schreiber. U.S. Pat. 1,398,948. *Chem. Abstr.* **16**, 822.

Motor Fuel for Airplanes.—W. T. Schreiber. U.S. Pat. 1,398,947. *Chem. Abstr.* **16**, 822.

Liquid Fuel.—L. Knight. Brit. Pat. 170,075. *Chem. Abstr.* **16**, 1007.

Motor Fuel.—A. S. Ramage, Assr. to Chemical Research Syndicate, Ltd. U.S. Pat. 1,409,404. *J. Soc. Chem. Ind.* **41**, 321A.

Motor Fuel.—Chem. Fabr. Worms A.-G. Ger. Pat. 341,162. *J. Soc. Chem. Ind.* **41**, 321A.

8. Kerosene.

A New Incandescent Burner for Kerosene and Heavy Hydrocarbons.—P. Waguet. *Rev. prod. chim.* **24**, 779. *Chem. Abstr.* **16**, 1003.

Developments in the Use of Paraffin for Coast Lighting. *Engineering* **113**, 541.

Patents.

Solidified Mineral Oil, Lubricants, Fire-lighters.—J. J. Akker. Brit. Pat. 166,274. *Chem. Abstr.* **16**, 826.

Burning Kerosene and Similar Fuels.—R. F. Metcalfe. U.S. Pat. 1,402,243. *Chem. Abstr.* **16**, 1007.

9. Gas Oil and Intermediate Oil.

10. Lubricants and Lubrication.

Mechanical Lubricators.—A. B. Smith. Diesel Engine Users Assoc. *Oil Engineering and Finance* **1**, 322.

External Lubrication of Engines and Compressors. *Lubrication* **7**, (12), 1.

Chassis Lubrication Methods. *Lubrication* **7**, (12), 7.

The Manufacture of Lubricating Oil from Mineral Oil.—Zeit. Ver. deutschen. Ingen. *Petr. Times* **7**, 478.

CUTTING LIQUIDS.—E. C. Bingham. *U.S. Bur. Standards Technologic Paper* 204. *J. of the Franklin Inst. Chem. Tr. J.* **70**, 325. *Oil Engineering and Finance* **1**, 539.

PETROLEUM AND LUBRICATION.—E. A. Evans. Inst. Marine Engineers. *Oil Engineering and Finance* **1**, 434.

FLAKE GRAPHITE AS A LUBRICANT. *Chem. and Met. Eng.* **26**, 316.

LUBRICATION AND LUBRICANTS. *Elec. Rev.* **79**, 770. *Gen. Elec. Rev.* 25, 129.

WHEN IS FUEL OR LUBRICANT GOOD ?—W. F. Parish. Amer. Soc. Lubrication Engineers. *Int. Petr. Reporter* **1**, 13.

THE NATURE OF STIFF LUBRICANTS.—A. Künkler. *Seifensieder Zeit.* **48**, 1011. *Chem. Abstr.* **16**, 769.

VISCOSITY AND FRICTION.—W. H. Herschel. *J. Soc. Autom. Eng.* **10**, 31. *Chem. Abstr.* **16**, 769.

"DIGESTS OF CURRENT SCIENTIFIC LITERATURE ON LUBRICATION AND ALLIED PROBLEMS." Nos. 1 and 2. Messrs. Ragosine & Co., London.

THE LUBRICATION OF STEAM TURBINES. Messrs. Ragosine & Co.

THICKNESS AND RESISTANCE OF OIL FILMS IN HIGH SPEED BEARINGS.—G. Stoney, R. O. Roswell & J. Massey. *Engineering* **113**, 249. *J. Soc. Chem. Ind.* **41**, 242A.

PRESENT POSITION OF THE THEORY OF LUBRICATION. *Gümbel. Forschungsarb. Geb. Ingenieurw.* **1920**, (224), 3. *Chem. Zentr.* **93**, II., 489. *J. Soc. Chem. Ind.* **41**, 243A.

BOUNDARY LUBRICATION: THE PARAFFIN SERIES.—W. B. Hardy and I. Doubleday. *Proc. Roy. Soc.* A. **100**, 550. *J. Soc. Chem. Ind.* **41**, 242A.

RELATION BETWEEN FLUID FRICTION AND TRANSMISSION EFFICIENCY.—N. MacCoull. *Lubrication* **8**, (1), 1.

COMPOUND CYLINDER OIL FOR SUPERHEATED STEAM CONDITIONS. *Lubrication* **8**, (1), 9.

DILUTION OF CRANK CASE OIL.—C. M. Larson. *Sci. Lubrication* **1**, Oct. 13, Nov. 8.

LUBRICATION AND THE STEAM BOILER.—E. L. Gross. *Sci. Lubrication* **1**, Oct. 8.

RICHTLINIEN FÜR DEN EINKAUF UND DIE PRÜFUNG VON SCHMIERMITTELN. Düsseldorf.—Stahleisen m.b.H.

DIE SCHMIERMITTEL—ANWENDUNG MINERALÖL—INDUSTRIE HANDBUCH.—(Edited by) M. Winter. C. R. Vincentz, Hanover.

LUBRICATION IN POWER PLANTS.—R. June. *Gas Age-Record* **49**, 263.

PATENTS.

LUBRICANT.—W. H. Wood. U.S. Pat. 1,398,759. *Chem. Abstr.* **16**, 770.

LUBRICATING OILS.—H. Klever. Ger. Pat. 337,157. *Oil Engineering and Finance* **1**, 540.

Screw-cutting Oil.—H. C. Claflin. U.S. Pat. 1,401,760. *Chem. Abstr.* **16**, 978. *Oil Engineering and Finance* **1**, 599.

Lubricant Suitable for Use in the Cylinders of Steam Engines and the Like.—H. Langer. Brit. Pat. 164,303. *J. Soc. Chem. Ind.* **41**, 321A.

Fuel Oil.

Liquid, Colloidal and Powdered Fuels. W. R. Ormandy. *Colliery Guardian* **122**, 311.

The Use of Fuel Oil.—F. T. Addyman. *Oil Engineering and Finance* **1**, 367.

The Composition of Flue Gases for Solid and Liquid Fuels.—E. Kraemer. *Feuerungstechnik* **10**, 3, 21, 34. *Chem. Abstr.* **16**, 634.

High Flash Points in Fuels.—J. B. Rathbun. *Petr. Age* **8**, (16), 91. *Chem. Abstr.* **16**, 639.

Burning Liquid Fuel.—W. N. Best. U.P.C. Book Co., Inc., New York. *Oil News* **11**, 341.

Fuel Oil Vapour Detector.—*Oil Engineering and Finance* **1**, 440.

Oil Fuel Progress.—F. T. Addyman. *Oil Engineering and Finance* **1**, 523.

Babcock and Wilcox Improved Oil Fuel System.—*Oil Engineering and Finance* **1**, 524.

The Application of Oil to Power Production. F. T. Addyman. *Oil Engineering and Finance* **1**, 524.

The Utilisation of Liquid Fuels in Hoffmann Kilns.—L. Mascard. *Bull. soc. encour.* **133**, 1192. *Chem. Abstr.* **16**, 1140.

Oil Fuel Burning.—J. J. Kermode. *Engineering* **113**, 370, 554.

Patents.

Fuel.—L. W. Bates. Brit. Pat. 165,418. *Chem. Abstr.* **16**, 484.

Fuel.—L. W. Bates. Brit. Pat. 165,423. *Chem. Abstr.* **16**, 484.

Fuel.—L. W. Bates. Brit. Pat. 165,419. *Chem. Abstr.* **16**, 485.

Fuels.—L. W. Bates. Brit. Pat. 165,421. *Chem. Abstr.* **16**, 485.

Fuels.—L. W. Bates. Brit. Pat. 165,420. *Chem. Abstr.* **16**, 485.

Fuel.—L. W. Bates. Brit. Pat. 165,422. *Chem. Abstr.* **16**, 485.

Fuel.—L. W. Bates. Brit. Pat. 165,425. *Chem. Abstr.* **16**, 486.

Fuels; Lubricants.—L. W. Bates. Brit. Pat. 165,424. *Chem. Abstr.* **16**, 486.

Appliances (Atomisers) for Burning Liquid Fuel alone or in Conjunction with Solid Fuel and Colloidal Mixtures.—G. U. Morgan and G. A. Clavey. Brit. Pat. 175,785. *J. Soc. Chem. Ind.* **41**, 286A.

Fuel.—G. P. Lewis. Brit. Pat. 172,065. *Chem. Abstr.* **16**, 1145.

Diesel Oil and Engines.

Boiler Oil for Diesel Engines.—J. L. Chaloner. *Motorship. Oil Engineering and Finance* **1**, 306.

Fuel Oils and their Application.—H. Moore. *Oil Engineering and Finance* **1**, 381.

Some Characteristics of Petroleum Oils used on Diesel Engines.—H. Moore. *Oil Engineering and Finance* **1**, 458. *Petr. World* **24**, 200. *J. Soc. Chem. Ind.* **41**, 318A.

Characteristics of Fuel Oils.—H. Moore. *Oil Engineering and Finance* **1**, 541.

The Lubrication of Diesel Engines.—Messrs. Ragosine and Co.

Fuel and Lubricating Oils for Diesel Engines.—W. Shenker. D. van Nostrand Co. New York.

Plant and Machinery.

"Reid-Erskine Liquid Fuel Atomiser and Burner."—*U.S. Commerce Repts.*, Jan., p. 27.

Colloid Mills and their Possible Applications.—H. Plauson. *Z. angew. Chem.* **34**, 469, 473. *Chem. Abstr.* **16**, 450.

Plauson's "Colloid Mill."—J. H. Frydlender. *Rev. prod. chim.* **24**, 731. *Kunststoffe* **11**, (22), 109. *Chem. Abstr.* **16**, 664.

Woidich Rectifying Tower Process.—V. B. Guthrie. *Nat. Petr. News* **14**, (7), 34. *Chem. Abstr.* **16**, 1312.

Patents.

Fractional Distillation of Petroleum or like Liquids.—Rosanoff Process Co., Assees. H. F. Perkins. Brit. Pat. 145,652. *J. Soc. Chem. Ind.* **41**, 168A.

Distilling Liquids.—G. W. Ellis. Brit. Pat. 164,407. *Chem. Abstr.* **16**, 367.

Fractional Distillation of Hydrocarbons.—E. H. French. U.S. Pat. 1,394,488. *Chem. Abstr.* **16**, 488.

Improvements Relating to Apparatus for Dehydrating Hydrocarbon Emulsions, Etc.—W. Cameron, Asiatic Petroleum Co. Brit. Pat. 173,644. *Petr. Times* **7**, 412.

Process of Distillation and Apparatus therefor. Chem. Fabr. Worms A.-G. Brit. Pat. 157,849. *J. Soc. Chem. Ind.* **41**, 205A.

Method and Apparatus for Heating Materials at Successively Different Temperatures.—Thermal Industrial and Chemical Research Co., A. McD. Duckham & J. S. Morgan. Brit. Pat. 174,690. *J. Soc. Chem. Ind.* **41**, 205A.

PROCESS FOR TREATING HYDROCARBONS.—A. J. Stephens. Canadian American Finance and Trading Co. Brit. Pat. 174,389. *J. Soc. Chem. Ind.* **41**, 209A.

(*a*) DEHYDRATOR FOR PETROLEUM EMULSIONS. (*b*) APPARATUS FOR REMOVING WATER FROM PETROLEUM EMULSIONS. (*c*, *g*) APPARATUS FOR DEHYDRATING PETROLEUM EMULSIONS. (*d*) SYSTEM OF WATER CONTROL FOR ELECTRICAL DEHYDRATORS. (*e*) DEHYDRATOR. (*f*, *n*) METHOD AND APPARATUS FOR DEHYDRATING PETROLEUM EMULSIONS. (*h*) DEHYDRATOR FOR PETROLEUM EMULSIONS AND WATER-CONTROLLED SYSTEMS FOR SAME. (*i*, *k*) PROCESS OF DEHYDRATING EMULSIONS. (*j*) PROCESS FOR DEHYDRATING PETROLEUM EMULSIONS. (l) METHOD AND APPARATUS FOR DEHYDRATING PETROLEUM OILS.—F. W. Harris, Assr. to Petroleum Rectifying Co. U.S. Pat. 1,405,117–30. *J. Soc. Chem. Ind.* **41**, 210A. *Oil Engineering and Finance* **1**, 600. *Chem. and Met. Eng.* **26**, 799. *Chem. Abstr.* **16**, 1149.

DISTILLING ASPHALTIC PETROLEUM.—E. F. Burch. U.S. Pat. 1,396,249. *Chem. Abstr.* **16**, 642.

APPARATUS FOR PURIFYING GASOLINE BY SEDIMENTATION, DECANTING AND FILTRATION.—W. Allison. U.S. Pat. 1,395,694. *Chem. Abstr.* **16**, 643.

DEHYDRATOR.—F. W. Harris. Brit. Pat. 175,352. *Chem. Age* **4**, 394. *J. Soc. Chem. Ind.* **41**, 244A.

FRACTIONAL DISTILLATION BY ELECTRIC HEATING.—F. Hansing. U.S. Pat. 1,398,856. *Chem. Abstr.* **16**, 770.

FRACTIONATING ASPHALTIC OILS.—P. Prutzman and G. L. Goodwin. U.S. Pat. 1,399,792. *Chem. Abstr.* **16**, 826.

PETROLEUM DISTILLATION APPARATUS.—T. J. Ryan. U.S. Pat. 1,397,984. *Chem. Abstr.* **16**, 826.

ROTARY PETROLEUM STILL.—D. A. Dean. U.S. Pat. 1,398,587. *Chem. Abstr.* **16**, 826.

FRACTIONAL DISTILLATION APPARATUS.—E. A. R. Chenard. J. Chenard, exor. U.S. Pat. 1,407,380. *J. Soc. Chem. Ind.* **41**, 240A.

METHOD AND MECHANISM FOR CENTRIFUGALLY SEPARATING SUBSTANCES (*e.g.*, PARAFFIN WAX FROM OIL).—H. A. Gill. The Sharples Specialty Co. Brit. Pat. 175,121. *J. Soc. Chem. Ind.* **41**, 244A.

STILLS (FOR CRUDE OIL).—P. Mather. Brit. Pat. 175,666. *J. Soc. Chem. Ind.* **41**, 284A. *Petr. Times* **7**, 699.

APPARATUS FOR DISTILLING OILS.—Stills. T. E. Robertson. From the Power Specialty Co. Brit. Pat. 176,099–102. *J. Soc. Chem. Ind.* **41**, 284A.

DISTILLATION OF HYDROCARBON OIL.—A. C. Armstrong. U.S. Pat. 1,408,242. *J. Soc. Chem. Ind.* **41**, 285A.

WAX-SWEATING APPARATUS.—A. Householder. U.S. Pat. 1,408,200. *J. Soc. Chem. Ind.* **41**, 286A.

PRODUCTION OF VERY VISCOUS LUBRICATING OILS, LEATHER GREASE, ARTIFICIAL VASELINE, LANOLINE-LIKE MATERIALS, ETC., FROM MINERAL, ANIMAL OR VEGETABLE OILS.—Plauson's Forschungsinstitut. G.m.b.H. Ger. Pat. 347,084. *J. Soc. Chem. Ind.* **41**, 300A.

OIL-FILTERING APPARATUS.—A. H. Franke. U.S. Pat. 1,402,411.

DISTILLING HYDROCARBONS.—Canadian American Finance and Trading Co., Ltd. Brit. Pat. 171,213. *Chem. Abstr.* **16**, 1010.

APPARATUS FOR DEHYDRATING MINERAL OILS.—L. Wirtz. U.S. Pat. 1,403,279. *Chem. Abstr.* **16**, 1011.

APPARATUS FOR REMOVING COKE FROM PETROLEUM STILLS.—C. B. Buerger. U.S. Pat. 1,401,310. *Chem. Abstr.* **16**, 1011.

FILTER FOR GASOLINE.—G. Giovannoni. U.S. Pat. 1,401,976.

FRACTIONAL DISTILLATION.—Thermal Industrial and Chemical (T.P.C.) Research Co., Ltd., and A. M. Duckham. Brit. Pat. 170,324. *Chem. Abstr.* **16**, 1119.

HEATING AND EVAPORATING LIQUIDS.—Thermal Industrial and Chemical Research Co., Ltd., and A. M. Duckham and J. S. Morgan. Brit. Pat. 170,617. *Chem. Abstr.* **16**, 1119.

FRACTIONATING PETROLEUM.—A. J. Paris, Junr. U.S. Pat. 1,405,155. *Chem. Abstr.* **16**, 1148.

DEVICE FOR CLEANING THE INTERIOR OF PETROLEUM STILLS.—A. D. Smith. U.S. Pat. 1,403,980. *Chem. Abstr.* **16**, 1149.

APPARATUS FOR OIL STRAINING AND SEDIMENTATION.—W. H. Summers. U.S. Pat. 1,405,876. *Chem. Abstr.* **16**, 1314.

PROCESS OF DEHYDRATING HEAVY OILS.—F. W. Harris. U.S. Pat. 1,410,673.

TESTING, ANALYSIS AND APPARATUS.

DETERMINATION OF WATER IN FUELS.—A. Marinot. *Ann. Chim. Analyt.* **4**, 7. *J. Soc. Chem. Ind.* **41**, 165A.

NEW TYPE OF ADIABATIC CALORIMETER.—W. Swientoslawski. *Rocz. Chem.* **1**, 157. *J. Soc. Chem. Ind.* **41**, 200A. *Chem. Abstr.* **16**, 363.

A NEW MODEL OF COMBUSTION BOMB OF KRUPP SPECIAL STEEL.—W. A. Roth, R. Macheleidt & J. Wilms. *Z. angew. Chem.* **34**, 537. *Chem. Abstr.* **16**, 366.

IMPORTED TURPENTINE AND TURPENTINE SUBSTITUTE.—M. Bottler. *Farben-Ztg.* **26**, 2915. *Chem. Abstr.* **16**, 504.

APPARATUS FOR THE DETERMINATION OF MOISTURE.—F. W. Shulenberger *Paint, Oil and Chem. Rev.* **72**, (25), 8. *Chem. Abstr.* **16**, 513.

THE DIFFERENCES IN THE MEASUREMENTS OBTAINED ON ADIABATIC AND ORDINARY CALORIMETERS.—W. Swientoslawski and H. & Z. Blaszkowskie. *Rocz. Chem.* **1**, 166. *Chem. Abstr.* **16**, 524.

A.S.T.M. TENTATIVE STANDARDS, 1921.—Am. Soc. Testing Materials. *Chem. Abstr.* **16**, 598.

THE DETERMINATION OF THE ABSOLUTE VISCOSITY OF PETROLEUM OILS.—W. H. Fulweiler and C. W. Jordan. *Petr. Times* **7**, 523.

A NEW METHOD OF COLOUR MEASUREMENT FOR OILS.—L. W. Parsons and R. E. Wilson. *J. Ind. Eng. Chem.* **14**, 269.

Method of Measuring Detonation in Engines.—T. Midgley and T. A. Boyd. *J. Soc. Autom. Eng.* **10**, 7. *Chem. Abstr.* **16**, 815.

Report of Committee D-2 on Petroleum Products and Lubricants.—C. P. van Gundy, *et al.* *Proc. Amer Soc. Testing Materials* **21**, 351. *Chem. Abstr.* **16**, 824.

Determination of Salt in Petroleum.—G. T. Dougherty. *J. Ind. Eng. Chem.* **14**, 80. *Chem. Abstr.* **16**, 825.

Determining Oil and Water in Paraffin Wax.—C. K. Francis and H. T. Bennett. *Nat. Petroleum News* **13**, (48), 31. *Chem. Abstr.* **16**, 825.

Determination of Aromatic Hydrocarbons in Fractions of Mineral Oils.—H. J. Waterman and J. N. J. Perquin. *Rec. Trav. Chim.* **41**, 192. *J. Soc. Chem. Ind.* **41**, 281A.

A Simple Receiver for Fractional Distillation under Reduced Pressure.—E. J. Williams. *Chem. News* **123**, 265. *Chem. Abstr.* **16**, 857.

Determination of Salt in Petroleum.—R. R. Matthews. *J. Ind. Eng. Chem.* **14**, 462.

The Analysis of Fuel, Gas, Water and Lubricants.—S. W. Parr. McGraw-Hill Book Co., New York and London.

New Calorimetric Bomb.—W. A. Roth. *Brennstoff Chem.* **3**, 104. *J. Soc. Chem. Ind.* **41**, 350A.

The Ideal Hydrometer.—W. Block. *Z. angew. Chem.* **34**, 434. *Chem. Abstr.* **16**, 1165.

Separation of Miscible Liquids by Distillation.—A. F. Dufton. *J. Chem. Soc.* **119**, 1988. *Chem. Abstr.* **16**, 1173.

The Most Recent Determination of the Ignition Temperatures of Fuels.—E. Daiber. *Z. Ver. Deut. Ing.* **65**, 1289. *Chem. Abstr.* **16**, 1307.

Determination of Colour of Lubricating Oils.—S. Born and R. S. Stone. *Nat. Petroleum News* **14**, (5), 67. *Chem. Abstr.* **16**, 1313.

Accuracy in Viscosity Determination.—*Lubrication* **8** (Feb.), 22.

The Effect of Bomb Corrosion on the Accuracy of Calorimetric Determinations.—H. L. Olin and R. E. Wilkin. *Chem. and Met. Eng.* **26**, 694.

Patents.

Viscosimeter.—H. N. Moody. U.S. Pat. 1,405,538. *J. Soc. Chem. Ind.* **41**, 235A.

Viscosimeters.—Hadfields (Morton), Ltd., and A. E. Bawtree. Brit. Pat. 169,204. *Chem. Abstr.* **16**, 665.

Cracking and Hydrogenation.

Something New in Refining.—L. S. Paddock. *Petr. Age* **9**, (5), 22. *Oil News* **11**, 358.

The Bergin Treatment of Mineral Oils and Coal.—*Petr. Times* **7**, 546.

ESTIMATION OF THE DEGREE OF "UNSATURATION" OF MINERAL OILS IN THE PROCESS OF BERGIUS.—H. J. Waterman and J. N. J. Perquin. *Rec. Trav. Chim.* **40**, 677. *Chem. Abstr.* **16**, 1009.

TUBE RETORTS AND PIPE STILLS.—*Oil News* **11**, 500.

PRODUCTION OF GASOLINE BY CRACKING HEAVIER OILS.—E. W. Dean and W. A. Jacobs. *U.S. Bur. of Mines Tech. P.* 258. *Oil Engineering and Finance* **1**, 490, 618.

PATENTS.

A. J. STEPHENS.—From Canadian American Finance & Trading Co., Ltd. Brit. Pat. 174,106. *J. Soc. Chem. Ind.* **41**, 168A.

W. H. ROSS.—U.S. Pat. 1,392,852. *Chem. Abstr.* **16**, 423.

SOCIÉTÉ E. BARBET ET FILS ET CIE. Brit. Pat. 169,182. *Chem. Abstr.* **16**, 488.

V. L. EMERSON.—Brit. Pat. 168,573.

C. P. DUBBS.—U.S. Pat. 1,392,629. *Chem. Abstr.* **16**, 488.

J. T. FENTON.—U.S. Pat. 1,394,481. *Chem. Abstr.* **16**, 488.

F. A. KORMANN.—Brit. Pat. 164,529. *Chem. Abstr.* **16**, 488.

F. TINKER.—U.S. Pat. 1,393,184. *Chem. Abstr.* **16**, 488.

R. YATES.—U.S. Pat. 1,395,075. *Chem. Abstr.* **16**, 488.

A. J. PARIS, JR.—U.S. Pat. 1,392,788. *Chem. Abstr.* **16**, 489.

F. B. LEWIS and T. S. COOKE.—U.S. Pat. 1,392,584. *Chem. Abstr.* **16**, 489.

R. FLEMING.—U.S. Pat. 1,394,987. *Chem. Abstr.* **16**, 489.

R. SEEGER.—U.S. Pat. 1,394,688. *Chem. Abstr.* **16**, 489.

C. M. ALEXANDER.—Assr. to Gulf Refining Co. U.S. Pat. 1,404,725. *J. Soc. Chem. Ind.* **41**, 209A.

A McD. MCAFEE.—Assr. to Gulf Refining Co. U.S. Pat. 1,405,054. *J. Soc. Chem. Ind.* **41**, 209A.

E. M. CLARK.—Assr. to Standard Oil Co. U.S. Pat. 1,405,286. *J. Soc. Chem. Ind.* **41**, 210A.

C. ELLIS.—U.S. Pat. 1,396,999. *Chem. Abstr.* **16**, 642.

J. T. FENTON.—U.S. Pat. 1,396,174. *Chem. Abstr.* **16**, 642.

E. F. ENGELKE.—Brit. Pat. 164,800. *Chem. Abstr.* **16**, 642.

E. F. ENGELKE.—Brit. Pat. 165,230. *Chem. Abstr.* **16**, 643.

E. F. ENGELKE.—Brit. Pat. 166,989. *Chem. Abstr.* **16**, 643.

J. W. TROTTER.—Brit. Pat. 165,167. *Chem. Abstr.* **16**, 643.

H. P. CHAMBERLAIN.—U.S. Pat. 1,400,419. *Chem. Abstr.* **16**, 826.

F. PUENING.—U.S. reissue 15,239 (original Pat. 1,358,174).

A. J. Stephens.—From Canadian American Finance & Trading Co. Brit. Pat. 174,965. *J. Soc. Chem. Ind.* **41**, 244A.

R. W. Hanna.—Assr. to Standard Oil Co. (California). U.S. Pat. 1,408,698. *J. Soc. Chem. Ind.* **41**, 285A.

M. Melamid.—Brit. Pat. 171,367. *Chem. Abstr.* **16**, 1008.

A. G. Bumell and R. W. Dawe.—Brit. Pat. 171,566. *Chem. Abstr.* **16**, 1008.

A. S. Ramage.—U.S. Pat. 1,403,194. *Chem. Abstr.* **16**, 1010.

J. W. Coast, Jr.—U.S. Pat. 1,400,800. *Chem. Abstr.* **16**, 1010.

W. T. Bryant.—U.S. Pat. 1,403,145. *Chem. Abstr.* **16**, 1010.

Trent Process Corporation.—Brit. Pat. 171,075. *Chem. Abstr.* **16**, 1010.

W. O. Snelling.—U.S. Pat. 1,402,455. *Chem. Abstr.* **16**, 1011.

E. V. Stone.—U.S. Pat. 1,403,457. *Chem. Abstr.* **16**, 1011.

A. McD. McAfee.—U.S. Pat. 1,405,054. *Chem. Abstr.* **16**, 1147.

E. F. Engelke.—Brit. Pat. 170,140. *Chem. Abstr.* **16**, 1148.

E. M. Clark.—U.S. Pat. 1,405,286. *Chem. Abstr.* **16**, 1148.

U.S. Pat. 1,395,075.—*Oil Engineering and Finance* **1**, 600.

B. Van Steenbergh.—U.S. Pat. 1,407,339–40. *J. Soc. Chem. Ind.* **41**, 321A.

J. B. Edwards.—Assr. to Tide Water Co. U.S. Pat. 1,410,175. *J. Soc. Chem. Ind.* **41**, 321A.

C. M. Alexander.—Assr. to Gulf Refining Co. U.S. Pat. 1,407,619. *J. Soc. Chem. Ind.* **41**, 321A.

E. M. Clark.—U.S. Pat. 1,410,797.

J. B. Edwards.—U.S. Pat. 1,410,175.

R. W. Hanna.—U.S. Pat. 1,406,698.

Insulating Oils.

The Catalytic Oxidation of Insulating Oils.—C. J. Rodman. *Petr. Times* **7**, 523.

Some Chemical Problems of Electrical Industries.—J. F. Brislee. Soc. Chem. Industry. *Chem. Tr. J.* **70**, 450.

Care of Transformer Oil.—*Elec. J.* **19**, 125.

Shale and Shale Oils.

The Brunswick Shale Deposits.—G. Howell. *Oil Engineering and Finance* **1**, 272.

Low Temperature Distillation of Oil from Shale.—T. G. Ironside. Trans. Inst. Marine Eng. *Oil Engineering and Finance* **1**, 294.

Germany's Oil-Shale Resources.—*Petr. Times* **7**, 294.

THE SHALE AND COAL OIL INDUSTRY.—*South African Mining and Eng. Jour. Petr. Times* **7**, 311.

THE DAY-HELLER OIL SHALE RETORT.—*Petr. Times* **7**, 547.

SOLUBILITY OF OIL SHALES IN SOLVENTS FOR PETROLEUM.—M. J. Gavin and J. T. Aydelotte. *U.S. Bur. Mines Repts. Investigations* 2313. *Petr. Times* **7**, 292.

OIL SHALE AND A FUTURE AMERICAN INDUSTRY.—D. A. Fell. *Petr. Times* **7**, 417. *Railroad Red Book* **39**, 379.

THE OIL SHALES OF ERMELO DISTRICT, NATAL.—*Petr. Times* **7**, 439.

COLORADO SHALE OILS.—A. J. Franks. *Chem. Met. Eng.* **25**, 731, 778. *Chem. Abstr.* **16**, 640.

RETORTING PROBLEMS OF COLORADO SHALES.—VI. R. D. George. *Railroad Red Book* **38**, 793. VII. *Railroad Red Book* **38**, 865. VIII. *Railroad Red Book* **38**, 929. *Chem. Abstr.* **16**, 641.

SOME RECENT OIL-SHALE DEVELOPMENTS.—J. T. Norman. *Petr. Times* **7**, 477.

GASOLINE FROM OIL SHALES.—R. H. McKee. *J. Frank. Inst. Int. Petr. Reporter* **1**, (6), 11. *Oil Engineering and Finance* **1**, 446. *Chem. Age, New York* **30**, 1. *Petr. Times* **7**, 519. *Chem. Abstr.* **16**, 1147.

NEW SOUTH WALES SHALE DEPOSITS ARE PROMISING.—*Int. Petr. Reporter* **1**, (11), 48.

OIL-SHALE ANALYSIS.—*Oil Engineering and Finance* **1**, 432.

A STUDY OF THE SATURATED AND UNSATURATED OILS FROM SHALE.—C. W. Botkin. *Chem. and Met. Eng.* **26**, 398.

SHALOILOGY AND OIL-SHALE NOMENCLATURE.—J. B. Jenson. *Chem. and Met. Eng.* **26**, 509.

RELATION OF SHALE-OIL RESIDUE TO OTHER BITUMENS.—C. W. Botkin. *Chem. and Met. Eng.* **26**, 445. *J. Soc. Chem. Ind.* **41**, 281A. *Petr. Times* **7**, 438.

DISTILLING OIL-SHALE WITHOUT RETORTS—*Pet. Times*, **7**, 510.

OIL SHALE IN THE UNION OF SOUTH AFRICA.—*Petr. Times* **7**, 510.

THE PROBLEMS OF THE AMERICAN SHALE-OIL INDUSTRY.—C. L. Jones. *Chem. and Met. Eng.* **26**, 546. *Petr. Times* **7**, 597,631.

SOME FACTORS AFFECTING PRODUCTS FROM DESTRUCTIVE DISTILLATION OF OIL SHALES.—L. C. Karrick. *Bur. Mines Repts. Investigations* 2324. *Oil Engineering and Finance* **1**, 407. *Petr. Times* **7**, 522. *Petr. World* **13**, 157. *Chem. Age (New York)* **30**, 112.

SHALE OIL DISTILLATION.—M. J. Gavin. *Oil Engineering and Finance* **1**, 484, 545.

PRINCIPLES AND METHODS OF OIL SHALE DISTILLATION.—D. E. Day. *Mining Sci. Press* **123**, 257. *Chem. Abstr.* **16**, 825.

THE EXTRACTION OF SHALE OIL.—E. and G. Urbain. *Bull. official direction recherches sci. ind. inventions* **1921**, 430. *Chem. Abstr.* **16**, 825.

APPARATUS FOR STUDYING THERMAL DECOMPOSITION OF OIL SHALES.—R. H. McKee and E. E. Lyder. *Chem. Met. Eng.* **25**, 1100. *Chem. Abstr.* **16**, 825.

SATURATED AND UNSATURATED OILS FROM SHALE.—C. W. Botkin. *Chem. and Met. Eng.* **26**, 398. *J. Soc. Chem. Ind.* **41**, 241A.

SHALE OIL IN SWEDEN AS A BY-PRODUCT OF LIME MANUFACTURE.—*Génie civil.* **79**, 21. *Chem. Abstr.* **16**, 1009.

THE QUANTITATIVE ANALYSIS OF OIL SHALE AND SHALE OIL.—D. E. Day. *The Day Co. Chemistry and Research Dept. Bull. No.* 2. *Chem. Abstr.* **16**, 1009.

BITUMEN CONTENT OF SWEDISH ALUM SHALE.—G. Hellsing. *Teknisk. Tid.* **51**, 73, 85, 89. *Chem. Abstr.* **16**, 1009.

THE SHALE AND COAL OIL INDUSTRY.—A. F. Craig and Co., Ltd. *Petr. Times* **7**, 677.

MINING OIL SHALE IN COLORADO.—R. L. Chase. *Min. and Sci. Press.* **124**, 373.

QUANTITY OF SHALE OIL PRODUCED IN AUSTRALIA.—*U.S. Commerce Reports*, p. 573.

ANALYTICAL DISTILLATIONS OF TYPICAL SHALE OILS.—M. J. Gavin. *U.S. Bur. Mines Repts. Investigations* 2332.

ARE WE READY FOR THE SHALE OIL INDUSTRY?—J. B. Jenson. *Salt Lake Min. Rev.* **23**, Mar. 30, 9.

VERTICAL OIL SHALE RETORTS MORE EFFICIENT THAN HORIZONTAL.—*Oil Trade J.* **13**, (2), 43.

PATENTS.

IMPROVED PROCESSES FOR OIL SHALE, ETC. DISTILLATION.—Brit. Pat. A. E. O'Dell. *Petr. Times* **7**, 349.

APPARATUS FOR DISTILLING HEAVY HYDROCARBONS, SHALE, AND THE LIKE.—W. D. P. Aims. U.S. Pat. 1,405,704. *J. Soc. Chem. Ind.* **41**, 210A. *Chem. Abstr.* **16**, 1314.

CONDENSER FOR SHALE OIL, ETC. J. A. Bishop. U.S. Pat. 1,395,898. *Chem. Abstr.* **16**, 514.

DISTILLING OIL FROM SHALE.—J. F. Fenton. U.S. Pat. 1,396,173. *Chem. Abstr.* **16**, 643.

PROCESS FOR THE TREATMENT OF OIL SHALES.—Plauson's Forschungsinst. G.m.b.H. G. P. 346, 459. *J. Soc. Chem. Ind.* **41**, 284A.

TREATING OIL SHALE.—S. H. Dolbear. Brit. Pat. 171,918. *Chem. Abstr.* **16**, 1149.

PETROLEUM FROM SHALE AND SANDS.—T. Kurokawa. Jap. Pat. 37,780. *Chem. Abstr.* **16**, 1313.

Lignites and Coals and their Products.

Low Temperature Distillation of Amalgams of Bituminous Non-Coking Coal and Asphaltic Oils.—J. D. Davis and C. E. Coleman. *U.S. Bur. Mines Repts. Investigations* 2312. *Chem. Met. Eng.* 26, 173. *J. Soc. Chem. Ind.* **41**, 168A. *Am. Gas J.* **116**, 83. *Gas Age-Record* **49**, 107. *Chem. Abstr.* **16**, 1001.

Low-Temperature Carbonisation.—The Improved Coalite Process. *Colliery Guardian* **122**, 1207. *Chem. Abstr.* **16**, 479.

The Change in Volume of Lignite after Drying.—Kegel. *Braunkohle* **20**, 161. *Chem. Abstr.* **16**, 481.

The Economic Value of Bituminous Lignite.—F. Seidenschnur. Braunkohle **20**, 145, 165. *Chem. Abstr.* **16**, 483.

Liquid Fuels from Coal.—H. Moore and A. Grounds. *Oil Engineering and Finance* **1**, 359.

Brown Coals and Lignite.—W. A. Bone. Royal Soc. Arts. *Oil Engineering and Finance* **1**, 416. *J. Soc. Chem. Ind.* **41**, 126R. *Gas World* **76**, 182.

The Acids of Montan Wax.—H. Tropsch and A. Kreutzer. *Brennstoff-Chem.* **3**, 49. *J. Soc. Chem. Ind.* **41**, 208A.

Formation of Phenols from the Bituminous Portion of Lignite.—E. Gräfe. *Brennstoff-Chem.* **3**, 56. *J. Soc. Chem. Ind.* **41**, 211A.

The Briquetting or Distillation of Brown Coal.—J. Herbing. *Warme Kalte-Tech.* **23**, 176. *Chem. Abstr.* **16**, 631.

Determination of the Specific Heat of Dried Lignite and Lignite Briquettes.—J. Baudenbacher. *Braunkohle* **20**, 433. *Chem. Abstr.* **16**, 631.

The Present Status of the Gasification Processes Applied to Lignites.—F. Siemens. *Brenns. u. Wärmewirtschaft* **3**, 47. *Elektrotechn. Z.* **42**, 1459. *Chem. Abstr.* **16**, 631.

The Production of Oil from Coal.—N. H. Freeman. *Colliery Guardian* **122**, 1536. *Chem. Abstr.* **16**, 631.

Importance of Water-Soluble Ash in Utilising Brown Coal.—T. H. Limberg. *Feuerungstecknik* **9**, 205. *Chem. Abstr.* **16**, 634.

Gas Manufacture and Tar Recovery, with Special Attention to Carbonisation of Lignites.—K. Arnemann. *Gas-u. Wasserfach* **64**, 665. *Chem. Abstr.* **16**, 634.

Lignite-producer Tar.—S. Ruhemann. *Ber.* **54***B*, 2565. *Chem. Abstr.* **16**, 636.

Lignite Carbonisation—Carbonised Residue Briquettes.—W. W. Odell. *Bur. Mines Rept. Investigations* 2298. *Chem. and Met. Eng.* **26**, 207. *Chem. Abstr.* **16**, 1002.

The Application of Raw Rhenish Brown Coal in the Industries. J. Weiss and H. Becker.—*Braunkohle* (14, 15 and 17) *Chem. Zeit.* **45**, 965. *Chem. Abstr.* **16**, 814.

A Lignite that Contains Sodium Chloride.—V. Morgenstein. *Z. öffentl. Chem.* **18**, 208. *Chem. Abstr.* **16**, 814.

THE PRODUCTION OF LIGHT MOTOR FUELS FROM LOW-TEMPERATURE COAL AND LIGNITE TAR, ESPECIALLY THE CONVERSION OF PHENOLS OR CREOSOTE INTO BENZENE.—F. Fischer. *Brennstoff, Chem.* **2**, 327. *Chem. Abstr.* **16**, 816.

LOW-TEMPERATURE CARBONISING RETORT.—A. Thau. *Coal Age* **20**, 913. *Chem. Abstr.* **16**, 817.

(LOW TEMPERATURE) DISTILLATION OF COAL.—K. Bunte. *Gas u. Wasserfach* **64**, 681. *Chem. Abstr.* **16**, 817.

GAS PRODUCTION WITH RECOVERY OF LOW-TEMPERATURE TAR.—Terres and Roser, et al. *Gas-u. Wasserfach* **64**, 683. *Chem. Abstr.* **16**, 817.

LOW-TEMPERATURE CARBONISATION AND THE HOME OIL SUPPLY (CONFERENCE AT CARDIFF).—*Oil Engineering and Finance* **1**, 513.

THE BROWN COAL DEPOSITS AT MOORLANDS, SOUTH AUSTRALIA.—*Ind. Austral.* Feb. 23, 1922. *J. Soc. Chem. Ind.* **41**, 175R.

LIGNITE-PRODUCER TAR.—F. Fischer. *Ber.* **55**, 505.

LOW-TEMPERATURE CARBONISATION.—J. Roberts. *Colliery Guardian* **122**, 1067, 445. *Chem. Abstr.* **16**, 1002.

DEVICES FOR SPEEDING LOW-TEMPERATURE CARBONISATION AND PROCURING A DENSE AND NON-FRIABLE PRODUCT.—A. Thau. *Coal Age* **20**, 873. *Chem. Abstr.* **16**, 1002.

LOW-TEMPERATURE CARBONISATION IN ENGLAND.—D. Brainlie. *Chem. Met. Eng.* **26**, 23. *Chem. Abstr.* **16**, 1002.

PRODUCTS OF LOW-TEMPERATURE DISTILLATION OF COAL.—W. Runge. *Chem. Age* (New York) **30**, 9. *Chem. Abstr.* **16**, 1001.

EFFICIENCY OF LOW-TEMPERATURE COKE IN DOMESTIC APPLIANCES.—M. W. Fishenden. *Fuel Research Board, Tech. Paper* 3; *J. Soc. Chem. Ind.* **41**, 13R; *Gas J.* **156**, 876; *Chem. Abstr.* **16**, 1007.

LIGNITE IN THE WESTERN PART OF THE FORT BERTHOLD, INDIAN RESERVATION, SOUTH OF THE MISSOURI RIVER, NORTH DAKOTA.—C. M. Bauer and F. A. Herald. *U.S. Geol. Surv. Bull.* **726**, 109. *Chem. Abstr.* **16**, 1144.

THE LIGNITE BASIN OF LEONESSA.—G. Pariente. *Rass. min.* **55**, 68. *Chem. Abstr.* **16**, 1144.

THE LIGNITE BASIN IN THE VALLEY OF MERCURE.—G. Pariente. *Rass. Min.* **55**, 69. *Chem. Abstr.* **16**, 1144.

NEW METHODS OF IMPROVING COAL.—G. Cantieny. *Umschau* **26**, 33. *Chem. Abstr.* **16**, 1144.

SOME CONSTITUENTS OF LIGNITES. II.—R. Cuisa and M. Croce. *Gazz. Chim. Ital.* **52**, I., 125. *J. Soc. Chem. Ind.* **41**, 318A.

LOW-TEMPERATURE CARBONISATION OF COAL.—*Iron and Coal Trades Rev.* **104**, 162. *Chem. Abstr.* **16**, 1308.

THE NATURAL SIGNIFICANCE OF LOW-TEMPERATURE CARBONISATION.—D. Brownlie. *Engineering* **113**, 125. *Chem. Abstr.* **16**, 1308.

TASCHENBUCH FÜR DIE DEUTSCHE BRAUNKOHLEN-UND KALI-INDUSTRIE.—Halle a. S. M. Börner.

Patents.

Process of Producing and Securing Products from Lignite.—J. H. Reid, Assr. to International Nitrogen Co. U.S. Pat. 1,403,633. *J. Soc. Chem. Ind.* **41**, 167A. *Chem. Abstr.* **16**, 1146.

Manufacture of Tar.—C. Falk, C. Falk, Junr., and M. Wangemann. Brit. Pat. 148,785.

Fuel.—F. F. Fournier. Brit. Pat. 167,148. *Chem. Abstr.* **16**, 637.

Lubricants.—R. Maclaurin and Scottish By-Products, Ltd. Brit. Pat. 169,573. *Chem. Abstr.* **16**, 770.

Treatment of Carbonaceous Materials.—W. E. Trent. Brit. Pat. 159,497. *J. Soc. Chem. Ind.* **41**, 243A.

Process for Dehydrating Lignite and Peat by Treatment with Solvents Miscible with Water.—M. Kruger. Ger. Pat. 346,291. *J. Soc. Chem. Ind.* **41**, 243A.

Manufacture of Drying Oils from Lignite and Producer-Gas Tar.—K. Bube. Ger. Pat. 345,855. *J. Soc. Chem. Ind.* **41**, 245A.

Process for Obtaining Paraffin and Highly-Viscous Lubricating Oils from Lignite Tar and Shale Tar.—E. Erdmann. Brit. Pat. 156,594. *J. Soc. Chem. Ind.* **41**, 285A.

Process for Producing a Smokeless Fuel from Lignite.—H. Pape. Ger. Pat. 342,128. *J. Soc. Chem. Ind.* **41**, 320A.

Low-Temperature Distillation.—E. Barrs. Brit. Pat. 177,239. *Chem. Age* **6**, 562.

Pitch, Asphalt and Bitumen.

The Occurrence of Coöngite in Central Asia.—R. J. Morgan. *Chem. Eng. Mining Rev.* **13**, 348. *Chem. Abstr.* **16**, 397.

The Asphalt Industry.—P. Hubbard. *Commercial American. Chem. Tr. J.* **69**, 656.

Mineral Rubber.—C. O. North. *Chem. and Met. Eng.* **26**, 253.

Trinidad's Famous Pitch Lake.—H. A. Judd. *Petr. Times* **7**, 501.

Determination of the Melting Point of Asphalts by the Krämer-Sarnow Method.—*Mat. grasses* **13**, 5934. *Chem. Abstr.* **16**, 825.

Patents.

Process of and Apparatus for Distilling Bituminous Materials.—D. Pyzel. Brit. Pat. 173,907. *J. Soc. Chem. Ind.* **41**, 168A.

Bituminous Cement.—G. A. Wilson, Junr. U.S. Pat. 1,394,874. *Chem. Abstr.* **16**, 476.

Bituminous Compositions.—W. J. Mellersh-Jackson. Brit. Pat. 169,079. *Chem. Abstr.* **16**, 476.

Coking Pitch.—F. Peuning. U.S. Pat. 1,390,879. *Chem. Abstr.* **16**, 487.

Bituminous Emulsion.—C. S. Reeve. U.S. Pat. 1,398,201. *Chem. Abstr.* **16**, 826.

FIRE-RESISTING ASPHALT COMPOSITION.—J. H. Young. U.S. Pat. 1,398,991. *Chem. Abstr.* **16**, 827.

DISTILLING BITUMINOUS MATERIALS.—Canadian American Finance and Trading Co., Ltd. Brit. Pat. 171,785. *Chem. Abstr.* **16**, 1011.

COMMINUTING AND COMPACTING BITUMINOUS MATERIAL.—R. P. Perry. U.S. Pat. 1,402,177. *Chem. Abstr.* **16**, 1011.

SPONGY ASPHALT.—A. C. Fischer. U.S. Pat. 1,401,974. *Chem. Abstr.* **16**, 1011.

PAVING BLOCKS.—J. S. Downard. U.S. Pat. 1,405,302. *Chem. Abstr.* **16**, 1143.

INSULATING MATERIAL.—J. P. ELLIOTT. U.S. Pat. 1,406,174. *Chem. Abstr.* **16**, 1288.

PARAFFIN, OZOKERITE, VASELINE.

PARAFFIN WAX—ITS EXTRACTION AND REFINING.—F. E. J. Foxall-Smedley. *Oil Engineering and Finance* **1**, 520.

COLOUR OF PETROLEUM MIXTURES AND PARAFFIN WAX.—M. Bomberg. *Petroleum* **18**, 361. *J. Soc. Chem. Ind.* **41**, 319A.

FOSSIL WAX OF MONTE FALO.—R. Cuisa and R. Vois. *Gazz. Chim. Ital.* **52**, I., 135. *J. Soc. Chem. Ind.* **41**, 320A.

HARDENED CANDLES.—*Seifensiederzeit.* **49**, 63. *Chem. Abstr.* **16**, 1330.

ORIGIN OF PETROLEUM.

THE INORGANIC ORIGIN OF PETROLEUM. H. W. Hixon. *Eng. Mining J.* **112**, 622. *Chem. Abstr.* **16**. 396.

OIL ORIGINS IN CALIFORNIA.—L. van der Leck. *Cal. State Mineralogist, Bull.* **89**. *Oil News* **11**, 322.

THE CHEMISTRY UNDERLYING THE THEORIES OF THE ORIGIN OF PETROLEUM.—J. E. Hackford. *Oil Engineering and Finance* **1**, 363.

ORIGIN OF ALBERTA TAR SANDS.—A. F. A. Coyne. *Petr. Age* **9**, (8), 22.

JAPANESE ACID CLAY (FULLER'S EARTH), ITS PROPERTIES, CHEMICAL APPLICATIONS AND THE RELATION TO THE GEOLOGICAL FORMATION OF PETROLEUM.—K. Kobayashi. *Kojin Kwagaku Zasshi* (*Eng. Chem. J.*), **1**, 15. *Chem. Abstr.* **16**, 1298.

NATURAL DISTILLATION OF PETROLEUM.—B. Williams. *Petr. Times* **7**, 696.

PRIMARY SOURCE OF PETROLEUM.—H. W. Hixon. *Engineering and Mining J. Petr. Times* **7**, 702.

NEW HYPOTHESIS OF THE ORIGIN OF NATURAL FUELS.—G. Calcagni. *Gazz. Chim. Ital.* **52**, 87. *J. Soc. Chem. Ind.* **41**, 318A.

PHYSICAL PROPERTIES OF PETROLEUM AND ITS PRODUCTS.

VISCOSITY OF MINERAL OILS.—H. Moore. *Oil Engineering and Finance* **1**, 320.

EFFECT OF PARAFFIN WAX ON THE PROPERTIES OF MINERAL OILS.—A. P. Bjerregaard. *J. Ind. Eng. Chem.* **14**, 215. *Oil Engineering and Finance* **1**, 539. *J. Soc. Chem. Ind.* **41**, 320A. *Chem. Abstr.* **16**, 1313.

THE CONVERSION FOR VISCOSITY READINGS.—H. Moore. *Oil Engineering and Finance* **1**, 383.

THE VISCOSITY OF BLENDS.—H. Moore. *Oil Engineering and Finance* **1**, 334.

CAPILLARY PROPERTIES OF MINERAL OILS.—D. Holde. *Chem. Zeit.* **46**, 3. *J. Soc. Chem. Ind.* **41**, 208A.

THE RELATION BETWEEN THE COMPOSITION OF VAPOUR AND LIQUOR IN DISTILLATION.—E. Piron. *Chem. and Met. Eng.* **26**, 317. *J. Soc. Chem. Ind.* **41**, 239A.

THE SURFACE TENSION OF PETROLEUM.—C. K. Francis and H. T. Bennett. *Petr. Times* **7**, 523. *Petr. World* **24**, 212.

CHANGES IN VISCOSITY OF OILS WITH THE TEMPERATURE.—W. H. Herschel. *Petr. Times* **7**, 523. *Petr. World* **24**, 212.

THE TWO-DIMENSIONAL SLOW MOTION OF VISCOUS FLUIDS.—L. Bairstow, B. M. Cave & E. D. Lang. *Proc. Roy. Soc.* **100***A*, 394. *Chem. Abstr.* **16**, 668.

VISCOSITY OF LIGHT OILS.—H. T. Bennett. *Petr. Age* **8**, (16), 26. *Chem. Abstr.* **16**, 825.

PHYSICAL STUDY OF ROUMANIAN BURNING OIL.—C. Predescu. *Bull. sec. sci. acad. Roumaine* **7**, 22. *Chem. Abstr.* **16**, 825.

HEAT UTILISATION IN FRACTIONAL DISTILLATION.—F. Bürk. *Chem. App.* **8**, 193, 203. *Chem. Abstr.* **16**, 976.

EFFECT OF PARAFFIN WAX ON VISCOSITY OF PETROLEUM OILS.—E. W. Dean and M. B. Cooke. *J. Ind. Eng. Chem.* **14**, 410.

THE FLOW OF FLUIDS THROUGH COMMERCIAL PIPE LINES.—R. E. Wilson, W. H. McAdams & M. Seltzer. *J. Ind. Eng. Chem.* **14**, 462, 105. *Chem. Abstr.* **16**, 1118.

CHEMISTRY OF PETROLEUM.

PETROLEUM A RAW MATERIAL FOR OUR CHEMICAL INDUSTRIES.—S. Born. *Chem. Age* (New York) **29**, 444.

SOME NEW PETROLEUM PRODUCTS.—J. H. James. *Chem. and Met. Eng.* **26**, 209. *J. Soc. Chem. Ind.* **41**, 208A. *Chem. Trade J.* **70**, 227.

THE ACTION OF SELENIUM UPON HIGH-BOILING MINERAL OILS.—K. Gräfe. *Z. angew. Chem.* **34**, 509. *Chem. Abstr.* **16**, 639.

PETROLEUM PREPARED FROM COLZA OIL. A. Mailhe. *Compt. rend.* **173**, 655. *Chem. Abstr.* **16**, 639.

POSSIBILITIES OF CHEMICAL RESEARCH IN PRODUCING BRANCH OF OIL INDUSTRY.—H. H. Hill. *Oil Weekly* **24**, (4), 15.

IODINE AND BROMINE VALUES OF PETROLEUM PRODUCTS.—E. M. Johansen. *J. Ind. Eng. Chem.* **14**, 288.

ALCOHOL FROM PETROLEUM.—Allgem. Oesterr. Chem. Tech. Zeit. *Oil Engineering and Finance* **1**, 480.

CHEMISTRY AS APPLIED TO PETROLEUM REFINING.—J. E. Hackford. *Oil Engineering and Finance* **1**, 517.

ARTIFICIAL PETROLEUM FROM FISH OILS.—II.—K. Kobayashi and E. Yamaguchi. *Kogyo-Kwagaku Zasshi.* (*J. Chem. Ind. Japan*) **24**, 1399. *J. Soc. Chem. Ind.* **41**, 242A.

ARTIFICIAL PETROLEUM FROM SOYA BEAN, COCONUT, AND CHRYSALIS OILS AND STEARINE.—K. Kobayashi. *Kogyo-Kwagaku Zasshi.* (*J. Chem. Ind. Japan*) **24**, 1421. *J. Soc. Chem. Ind.* **41**, 242A.

INFLUENCE OF THE ELEMENTS OF THE OXYGEN GROUP ON PARAFFIN WAX.—H. Siebeneck. *Petroleum* **18**, 281. *J. Soc. Chem. Ind.* **41**, 282A.

THE PIONEER'S FIELD IN PETROLEUM RESEARCH.—Van H. Manning. *J. Ind. Eng. Chem.* **14**, 379.

PATENTS.

ALCOHOLS AND ALDEHYDES FROM HYDROCARBONS.—C. H. Bibb. U.S. Pat. 1,392,886. *Chem. Abstr.* **16**, 424.

PROPYLENE.—H. F. Saunders. U.S. Pat. 1,393,248. *Chem. Abstr.* **16**, 489.

PROPYLENE.—H. F. Saunders. U.S. Pat. 1,393,249. *Chem. Abstr.* **16**, 489.

PROCESS FOR THE PRODUCTION OF (ORGANIC) ACIDS FROM NATURAL GAS, MINERAL OIL AND ITS DISTILLATION PRODUCTS, PRODUCER-GAS, TAR, ETC.—H. Strache. Ger. Pat. 344,877. *J. Soc. Chem. Ind.* **41**, 210A.

PROCESS OF PRESENTING HYDROCARBON IN THE FORM OF A THIN FILM OF LARGE SURFACE AREA TO THE ACTION OF AN OXIDISING AGENT.—E. Gevers-Orban. U.S. Pat. 1,404,435. *Chem. Abstr.* **16**, 1147.

PROCESS FOR RAISING THE VISCOSITY AND BOILING POINT OF MINERAL OILS FOR PRODUCING LUBRICANTS.—Chem. Fabr. Dubois und Kaufmann. Ger. Pat. 346,309. *J. Soc. Chem. Ind.* **41**, 245A.

HYDROCARBONS, ETC.—METHOD OF TREATING.—A. S. Ramage. Assr. to Bostaph Engineering Corp. U.S. Pat. 1,407,770. *J. Soc. Chem. Ind.* **41**, 285A.

HYDROCARBON OILS.—K. Kobayashi. Brit. Pat. 170,264. *Chem. Abstr.* **16**, 1147.

OIL GAS AND PETROL GAS.

COMPRESSED OIL-GAS HYDROCARBON.—A. G. Burnell and R. W. Dawe. *Gas J.* **157**, 640.

PATENTS.

OIL-GAS MAKING APPARATUS.—A. Seidler. U.S. Pat. 1,394,446. *Chem. Abstr.* **16**, 487.

MISCELLANEOUS.

"THE OIL ENCYCLOPEDIA."—M. Mitzakis. Chapman and Hall, Ltd.

THE PETROLEUM COMPTOMETER.—A Novel Invention. *Oil News* **11**, 242.

THE ELEMENTS OF FRACTIONAL DISTILLATION.—C. S. Robinson. McGraw-Hill Book Co., Inc., London and New York.

THE STATISTICAL CLASSIFICATION FOR PETROLEUM AND ITS PRODUCTS.—*U.S. Commerce Repts.*, January, p. 194.

QUANTITATIVE RELATIONS BETWEEN COMPOSITION OF FUELS AND THE VOLUME OF GASES OF COMBUSTION. THE EQUATIONS OF COMBUSTION PROCESSES.—R. Mollier. *Z. Ver deut. Ing.* **65**, 1095. *Chem. Abstr.* **16**, 477.

THE PETROLEUM INDUSTRY IN 1920. R. Kissling. *Chem. Zeit.* **45**, 1121, 1145, 1169, 1173, 1197.

THE WORLD'S OIL SITUATION AND ITS EFFECT UPON AMERICAN PETROLEUM PROPERTIES.—B. Bryan. "The Magazine of Wall Street." *Petr. Times* **7**, 455.

AMERICAN ORGANISATION. THE SINCLAIR CONSOLIDATED OIL CORPORATION.—G. Howell. *Oil Engineering and Finance* **1**, 385.

OIL OPERATOR'S RIGHTS.—*Oil Engineering and Finance* **1**, 390.

OIL COOLING (OF ENGINES).—J. A. Secor. *J. Soc. Autom. Eng.* **9**, 310. *Chem. Abstr.* **16**, 641.

EXTENT OF POTASH DEPOSITS IN OIL FIELDS.—*Chem. and Met. Eng.* **26**, 300.

RECENT ARTICLES ON PETROLEUM AND ALLIED SUBSTANCES.—E. H. Burroughs. *U.S. Bur. Mines Repts. Investigations* 2317, 2305, 2330.

CONSERVING OIL SUPPLIES.—*Oil Engineering and Finance* **1**, 516.

THE BUREAU OF MINES EXPERIMENTAL TUNNEL FOR STUDYING THE REMOVAL OF AUTOMOBILE EXHAUST GAS.—A. C. Fieldner and J. W. Paul. *U.S. Bur. Mines Repts. Investigations* 2288. *Engineering* **112**, 872. *Chem. Abstr.* **16**, 1006.

SPECIFICATIONS FOR PETROLEUM PRODUCTS ADOPTED BY THE INTERDEPARTMENTAL PETROLEUM SPECIFICATIONS COMMITTEE, EFFECTIVE JANUARY 23, 1922.—*U.S. Bur. Mines Tech. Paper* 305.

THE PETROLEUM INDUSTRY. A BRIEF SURVEY OF THE TECHNOLOGY OF PETROLEUM.—(Edited by) A. E. Dunstan. Institution of Petroleum Technologists.

LE PÉTROLE, ORIGINE, GISEMENTS, COMMERCE, SUCCÉDANÉS. PARIS AND LIÈGE. C. Béranger.

PHYSICS AND THE DIVINING ROD.—C. von Klinckowström. *Allge. öst. Chem.-Tech. Zeit.*, May 1. *Oil Engineering and Finance* **1**, 623.

THE OIL SUPPLY OF THE WORLD.—D. White. *Eng. and Min. J.* **113**, 455.

CARBURETTOR ADJUSTMENT BY GAS ANALYSIS.—A. C. Fieldner and G. W. Jones. *Chem. and Met. Eng.* **26**, 731.

THE MID-CONTINENT YEAR BOOK.—Mid-Continent Oil and Gas Association, Tulsa, Okla.

MOST REMARKABLE OIL POOL IN WORLD.—*Oil Trade J.* **13**, (4), 84.

PATENTS.

OILS.—Trent Process Corporation. Brit. Pat. 167,738. *Chem. Abstr.* **16**, 642.

DEVICE FOR DEODORISING EXHAUST GASES FROM INTERNAL-COMBUSTION ENGINES.—P. Wachtel. U.S. Pat. 1,402,814. *Chem. Abstr.* **16**, 1008.

OIL TRAP.—U.S. Pat. 1,397,891. *Oil Engineering and Finance* **1**, 599.

AMERICAN CHEMICAL SOCIETY.

PETROLEUM SECTION.

Abstracts of papers read at the third meeting of the Petroleum Section of the American Chemical Society, Birmingham, Ala., April, 1922.

VOLUME CHANGES IN PETROLEUM PRODUCTS.—A. P. Bjerregaard.

This paper will deal with some peculiarities exhibited by petroleum oils under changes of atmospheric temperature conditions when the oil is in tank cars. A set of expansion coefficients that fit the observed phenomena will be included.

THE SURFACE TENSION OF PETROLEUM.—C. K. Francis and H. T. Bennett.

The surface tension of petroleum from different sections of the United States, and of the products derived from the various crudes, was determined in order to ascertain whether a relation existed between the surface tension and any other physical properties of the oils.

The surface tension of petroleum varies almost directly with the specific gravity, but is influenced by the asphaltic content. The presence of high boiling fractions and high viscosity products tends to raise the surface tension of the lighter petroleum products, such as gasoline and naphtha.

The small quantity of sulphur compounds, amorphous and crystalline wax, fatty acids and related substance commonly found in petroleum products, do not appear to appreciably influence the surface tension.

The surface tension at 85° F. of the substances examined varies as follows :—

Crude	28·8	31·2
Gasoline	24·4	25·8
Naphtha	26·3	29·2
Kerosene	30·7	31·2
Gas oil	33·1	
Lubricating oil	36·0	37·5
Gas distillate	33·6	36·2

SOME NOTES ON THE DETERMINATION OF THE ABSOLUTE VISCOSITY OF PETROLEUM OILS.—W. H. Fulweiler and C. W. Jordan.

In connection with the determination of absolute viscosity of certain samples of petroleum products, it was noted that the viscosities decreased when the sample had been left in the viscosimeter for 24 hours. In other samples the viscosity increased on standing. Some data is given showing the effect on viscosity of various samples of petroleum, vegetable and animal oils. Some suggestions are made as to the cause of this phenomenon.

THE CHANGE IN VISCOSITY OF OILS WITH THE TEMPERATURE.—Winslow H. Herschel.

It is often necessary to estimate the viscosity of an oil at one temperature from an observation made at another. While it is not convenient to do this by equations, because no two petroleum oils are alike, and the relation between viscosity and temperature is complex, a graphical method has been developed which it is believed is accurate

enough for commercial purposes. The method depends upon the observed fact that the graphs of a logarithmic viscosity-temperature diagram will, under certain conditions, meet at a point.

DETONATION CHARACTERISTICS OF BLENDS OF AROMATIC AND PARAFFIN HYDROCARBONS.—Thomas Midgley, Jr., and T. A. Boyd.

The compressions to which aromatic hydrocarbons can be subjected in internal-combustion engines without detonation are very high as compared to the initial compressions that can be employed when paraffin hydrocarbons are used as fuel. Accurate measurements have been made through a wide range of relative composition of the tendency of blends of these hydrocarbons to detonate in engines. Values are given for the limiting compression ratio at which the various blends will give combustion that is free from detonation. The new instrumentation used for the accurate measurement of the degree of detonation occurring during the combustion of the fuel mixture in the engine is described.

THE CATALYTIC OXIDATION OF INSULATING OILS.—C. J. Rodman.

Many oils used in electrical apparatus for insulating purposes tend to slowly form "deposits" known to the trade as oil sludge. Experiments have been carried out in both open and closed systems to substantiate the view that numerous substances may act continuously in small quantities to materially assist in the formation of the undesirable sludge. Such substances found somewhere in the transformer or circuit breaker construction are: copper, brass, lead, iron, tin, organic resins, oxidised asphaltic "varnishes" and some loading materials such as magnesia, calcia, and a small proportion of certain driers found in the protective paints.

Properly protected materials of electrical apparatus construction are discussed as well as the desirability of protecting the oil from oxygen contact.

CORROSION OF PETROLEUM REFINING EQUIPMENT.—R. R. Matthews and P. A. Crosby.

The authors have shown in earlier papers that, in refining Mid-Continent petroleum in a so-called pipe still, hydrochloric acid was formed, due to hydrolysis of the magnesium chloride in the brine associated with the petroleum. Ammonia has been used in the fractionating system to reduce the corrosion caused by the acid. The cost has been small and results gratifying.

This paper shows that hydrochloric acid is also produced when Mid-Continent crude is refined in shell stills arranged in series for continuous operation. The action was especially noted in stills where the oil temperatures were 175° C. to 250° C., and where bottom steam was used.

The acid corrosion was also noted in a heat exchanger where the outgoing crude oil was not over 110° C. Evidently the acid formation was small there, however, as the exchanger was in use 1½ years before a tube was corroded badly enough to give away.

RECENT DEVELOPMENTS IN THE METHODS FOR THE EXTRACTION OF GASOLINE FROM NATURAL GAS.—Fred E. Hosmer and F. M. Seibert.

The commercial importance of the natural gas gasoline industry is reviewed. The chemistry of natural gas is briefly discussed. Two new methods of gasoline extraction are described.

The first is known as the low pressure evaporation method, in which the crude product is utilised to furnish refrigeration for cooling the gas after being subjected to pressure.

The second method is known as the crude oil absorption method. This method consists in subjecting the gas to about fifty pounds pressure, at ordinary temperatures, and absorbing the gasoline in crude oil, carrying the saturation to about 25 per cent.

PETROLEUM EDUCATION.—Edwin De Barr and Fred W. Padgett.

A survey of Petroleum Education from the standpoint of pedagogy and practical application throughout the course of several years. The paper is outlined as follows :—

I. Relation of the various branches of Engineering to the Petroleum Industry.
II. Theoretical discussion of Petroleum Education.
III. Petroleum Education at the University of Oklahoma.
IV. The future of Petroleum Education.

The writers realise that the subject of Petroleum Education, especially from the standpoint of chemistry, is in a formative stage, and it is hoped that the present paper will stimulate discussion, and that outlines of courses in other institutions will be presented.

Abstracts.

Compiled by S. Bowman, A.I.C., Harold Moore, M.Sc., and F. G. P. Remfry, B.A., D.Sc., A.I.C.

General.

Paraffin Wax, the Composition of.—F. Francis, J. C. Pope & R. H. Coysh. *J. Chem. Soc.* 1922, 496–513.

The paper describes the preliminary and comprehensive experiments made in an attempt to determine the nature of the hydrocarbons constituting that relatively stable and inactive substance paraffin wax.

Following the line of previous workers—Bergmann (*Z. angew. Chem.* 1918, **31**, 69, 115, 148); Kelber (*Ber.* 1920, **53**, 66, 1567); Fischer and Schneider (*Ber.* 1920, **53**, 922); Grün (*Ber.* 1920, **53**, 987); Löffl (*Seifen Z.* 1920, **27**, 622)—oxidation by means of air and oxygen has been chosen as the most promising line of attack, but whereas the former employed temperatures ranging from 130° to 200° C., the authors prefer 100–110° C. The higher temperatures employed no doubt caused partial or complete rupture of the molecules of those constituents of high molecular magnitude, as is shown by the variety and lower mol. wt. of the resulting compounds.

Oxidation at 100° C., however, even with oxygen, takes place extremely slowly, but Francis found that in the presence of a small amount (5%) of turpentine oxidation takes place readily, and that the derivatives are less numerous and comparable in molecular magnitude with the hydrocarbons constituting the original wax.

The role of turpentine is at present being investigated, and while there is no doubt as to it accelerating the velocity of reaction, the process is probably one of auto-oxidation. Oxygen, as might be expected, is more active than air as an oxidising agent, and at 100° C. the action appears to proceed further.

Oxidation, however, is never complete, there being always a residue unacted upon even after separation and further treatment, and it is interesting to note that the synthetic paraffins hexadecane $C_{16}H_{34}$, and dotriacontane $C_{32}H_{66}$, resist oxidation when treated under similar conditions. It would appear from these facts that oxidation is a means of differentiating between what are probably normal paraffins and those constituents of wax which undergo oxidation, this view receiving additional support from the fact that it is possible to obtain certain fractions under high vacuum distillation which are more readily oxidised than others.

The Action of Air and Oxygen.

The material employed in these experiments was a commercial sample of paraffin wax M.P. 55–56° C., C 85·15, H 14·85, mol. wt. 360, thus corresponding closely to the composition of an average wax. On passing a current of air (free from CO_2) through the molten wax at a temp. of 101–103° C. in a thermostat, no oxidation was observed up to a period of 333 hours.

Using oxygen instead of air, the interesting fact was observed that oxidation did not commence until the gas had passed for 862 hours,

thus suggesting a latent period in which some change is taking place preparatory to oxidation.

The Action of Air and Oxygen in the Presence of Turpentine.

Repeating the above experiment with air, but with an addition of 5% turpentine to the wax, the resulting material contained 10·8% of O after 333 hours, and in the case of oxygen 19% was absorbed after 696 hours at the lower temp. of 100° C.

It will thus be noticed that the velocity of the reaction is greater with oxygen even for a lower temp., and that the oxidation proceeds further. Prolonging the treatment with O produced no further oxidation, but the M.P. of the product increased, showing some change had taken place.

The presence of moisture in the gas was found to inhibit the reaction.

Investigation of the Products of Air Oxidation.

The products may be roughly divided into two main groups:

A. Minor products of a volatile nature consisting of water, CO_2 and formic acid, together with oxidised products of turpentine.

B. The residue, resembling beeswax, consisting of:
   1. Small quantity of acidic compounds of low mol. wt. provisionally called γ acids.
   2. Acid compounds of high mol. wt.
   3. Non-acidic compounds containing oxygen.
   4. Unchanged hydrocarbons.

Separation of the acidic bodies was effected by dissolving 100 gms. of the molten product in 400 c.c. absolute alcohol, adding 10 c.c. of 40% NaOH sol., and adding slowly 200–250 c.c. of hot water. Two layers formed, the upper one consisting of unchanged wax and the lower one a solution of alkaline salts which on acidification gave a dark coloured oil solidifying on cooling.

These more or less crude fractions were washed and analysed, the acidic material found to have M.P. 42° C., mol. wt. 440, C 74·4, H 11·4, O 14·2, acid value 120; and the non-acidic portion M.P. 45–50, C 81·4, H 13·7, O 4·9. Further purification of these fractions proved a matter of great difficulty, but it was found possible in the case of the acid bodies to separate into sol. and insol. Ba salts corresponding to acids provisionally classified as "α" and "β" respectively.

The α acids gave M.P. 9–10° C., C 73·6, H 11·0, O 15·4, acid value 89; and the β acids M.P. 42° C., C 74·0, H 11·9, O 14·1, acid value 154. The non-acidic portion on separation from the unchanged wax by means of boiling acetone were found to consist of a semi-solid substance containing 10·2% O and a liquid containing 13·0% O.

The yields obtained from air oxidation in presence of turpentine were:

	%
α and β acids	32·0
γ acids	2·5
Inert oxidised hydrocarbons containing 10% O	10·0
Hydrocarbons M.P. 55–64° C.	19·0
Material of high mol. wt.	1·5
Mixture of hydrocarbons and non-acidic oxidised material containing 3–4% O	16·0
Mixture similar to above containing 7–8% O	17·0

Separation of the Products of Oxidation with Oxygen in Presence of Turpentine.

Similar experiments were carried out with oxygen at a temp. of 100° C., and while the products appeared to be of a similar nature the yields were greater than with air, viz. 47% of β and 7% of γ acids being produced. The α and β acids are the main products of air oxidation and the β and γ acids the main products of O oxidation. These acids are undoubtedly mixtures, and it has been found possible to effect further separation by means of the lead salts, the β acid consisting of at least four constituents. S. B.

PARAFFIN WAX; EFFECT OF—ON THE PROPERTIES OF MINERAL OILS.—A. P. Bjerregaard. *J. Ind. Eng. Chem.* 1922, **14**, 215–217.

Since paraffin wax occurs naturally as a component of many crude oils experiments were made in order to determine what effect the presence of this component has on the properties of the other components of petroleum such as the lubricating oil fractions. The materials used included samples of laboratory and commercially refined waxes and various grades of lubricating oils ranging from a light machinery oil to heavy cylinder stock.

Specific Gravity, Freezing Point and Viscosity of the various oils were noted before and after additions of wax up to 50% by weight. The results were as follows:

Specific Gravity is lowered, the relationship to percentage of wax added being a straight line curve.

Freezing Point is raised according to a definite relationship depending solely on the percentage added.

Viscosity is lowered to a marked extent in the case of very viscous oils, e.g. an oil with a viscosity of 320 secs. (Saybolt) showed a viscosity of 244 secs. with 10% of added wax. This effect diminishes with the less viscous oils, and shows no effect in the case of an oil with viscosity of 67 secs. S. B.

IODINE AND BROMINE VALUES OF PETROLEUM PRODUCTS.—E. M. Johansen. *J. Ind. Eng. Chem.* 1922, **14**, 288–291.

The general experience of those who have had occasion to determine Iodine and Bromine Values of Petroleum products is that the usual methods as applied to fatty and vegetable oils are not satisfactory, inasmuch as the results give no time indication of the degree of unsaturation.

This is due in most cases to a certain amount of substitution taking place, and the present investigation was undertaken with a view to ascertaining what correction should be made for this side reaction.

As a consequence of substitution the halogen acid is formed, and the determination of this is taken as the measure of correction to be applied.

Instead of the ordinary Hanus or Wigs solution in acetic acid, the author uses a carbon tetrachloride solution containing the equivalents of Br. and I. The Bromine solution used was of 0·2 N. strength in the same solvent. The former solution was found to be fairly stable if unexposed to light, but the latter required checking each time of use.

In the method employed 5 grms., or less in the case of cracked spirit, was diluted to 50 c.c. with CCl_4 and 10 c.c. of this solution introduced

into the reaction flask together with 25 c.c. of the reagent, a blank containing the same quantities being run at the same time. The flasks, provided with a stopper carrying a small separating funnel, were kept at 20° C. for 30 mins. protected from the light. 10 c.c. of a 15% Pot. Iodide solution and 100 c.c. of freshly boiled distilled water (cooled) were then carefully run in from the funnel to absorb any halogen acid present, the flask during this stage being immersed in ice water and the free halogen titrated in the usual manner with 0·1 N. Thiosulphate. The acid formed as a result of any substitution reaction was determined according to McIlhiney's method by adding 4 c.c of 4% Pot. Iodate solution and again titrating with thiosulphate.

From the difference between the titration of the blank and the reactions were found:

A = Total amount of halogen absorbed;
B = Amount of halogen present as acid; then
A—2B = Halogen combined by addition; and
B = Halogen combined by substitution.

These quantities were calculated to per cent. of the oil used and recorded as "addition value" and "substitution value" respectively. A series of determinations made on petroleum products and fatty oils, comparing the new solution and the Hanus solution, showed that the total amount of halogen absorbed by each of the petroleum products from the new solution was higher than that absorbed from the Hanus solution, and in neither case represented the actual content of unsaturated bodies present.

The results obtained by the two solutions on the fatty oils were irregular, the Hanus solution in this case giving slightly higher results. The accuracy of the method was determined by making dulplicate experiments by different analysts, and showed close agreement.

The new solutions were used for determining the Iodine and Bromine values of two crude oils and their fractions obtained by steam distillation, and the results showed that while the total per cent. of halogen absorbed increased rapidly with the boiling point, this increase was mainly due to increase in substitution. The addition values did not change to such an extent, and no constant relations were found between the Iodine and Bromine value of the same fraction.

The values of a number of typical petroleum products are given. In some cases it was noticed that the addition value was a negative quantity, i.e. the amount of substituted halogen being apparently greater than the total halogen absorbed. This was found to be due to other acid bodies being present such as naphthenic acids, and also to some extent to hydrolysis of the halogen compounds formed. The latter can be remedied by adding a more concentrated solution of Iodide, but the former constitutes a drawback to the method when applied to unrefined products, and requires further investigation.

It was also observed that the increase of absorption obtained by increasing the ratio of reagent was due to an increase in the substitution value, the addition value remaining constant. Similarly the time allowed for reaction effected the substitution value rather than the addition value. S. B.

Oils; A New Method of Colour Measurement for.—L. W. Parsons and R. E. Wilson. *J. Ind. Eng. Chem.* 1922, **14**, 269–278.

In the course of a research on decolorising processes as applied to mineral oils the authors encountered difficulties due to deficiencies of

the existing methods for an accurate determination of colour value, and were consequently led into an extensive investigation involving a detailed study of the fundamental principles of colour determination.

The Lovibond method was originally selected as likely to give the most satisfactory results, and while this instrument was found to be fairly accurate for the light coloured oils, it was found to be quite unsuitable for the wide range of colour met with in the darker shades.

This was found to be due principally to:

1. The wide separation of the squares of light.
2. The difficulty in matching the darker shades associated with heavy oils.
3. The scale not being "true" in the sense that the colours are not additive.

A detailed study of the principles underlying colour measurement was therefore made, and it was found that Beer's Law, which states that the effect of doubling the concentrations of the colouring matter is the same as doubling the thickness, holds good in the case of mineral oil where ionisation is absent. It was also observed that practically all paraffin base oils from pale spindle to dark cylinder stock have essentially the same light absorption curve when viewed through a sufficiently thin film.

A method was eventually worked out which depends on the relative depth of oil required to match a known standard. The Duboscq instrument was adopted for this purpose, modified to give an accurate measurement of the depth of oil or thickness of film ranging from 100 mm. to 0·1 mm.

The standard consists of a solution of heavy cylinder oil in water-white kerosene of such dilution to accurately match at 50 Lovibond colour glass, this standard being selected because up to this point the Lovibond and True Colour curves are in agreement. Further, a standard of this type has the same absorption spectrum as the oils themselves. For oils with a true colour less than 3 a cell giving a depth of 100 mm. is used, and for a colour between 3 and 200 a 50 mm. cell is used. Outside this range, say, from 200 to 4500 a special type of cell is used, giving films varying from 1·1 mm. to 0·14 mm. in thickness. These latter cells, used for the darkest shades, are made by cementing two parallel plates of optical glass together with a microcope slide of known thickness between, a space being left between the plates for receiving a few drops of the oil under examination. In all cases a match is made with the standard, the depth of which is varied between 4 and 12 mm., and the true colour, a figure proportional to the amount of colouring matter present, calculated from the formula,

$$\frac{\text{Colour of unknown}}{\text{Colour of standard}} = \frac{\text{Depth of standard required to match.}}{\text{Depth of layer of unknown oil.}}$$

The method has the advantage in that the values are additive, thus enabling the colour of a mixture of any two oils to be predicted when the values of each are known.

A curve showing the relationship between the new method and Lovibond values is also given, so that results obtained with that instrument can be easily converted to the true colour scale. S. B.

CARBON BLACK FROM NATURAL GAS IN 1921.—*Chem. and Met. Eng.* 1922, **26**, 754.

The United States Geological Survey reports marked progress during 1921 in the carbon black industry, the output being 14% greater than in 1920. A table of production from each State is given, Louisiana heading the list with 31,034,000 lbs. The yield per 1000 cu. ft. of gas consumed ranged from 0·2 so 3·5 lbs. 20–25% of the total output went to printers' ink, 30–35% to the rubber industry as a reinforcing agent, and a considerable amount exported for similar purposes. The industry is important in developing new gas fields, especially when remote from populous districts and favourable markets for domestic purposes. The Monroe field in Louisiana is an example. The Department of Conservation of this State now require that gasoline shall be extracted before the gas is burned. F. G. P. R.

EFFECT OF BACK PRESSURE ON OIL PRODUCTION.—*Chem. and Met. Eng.* 1922, **26**, 971.

The American Bureau of Mines has found that oil wells when kept under a back pressure of several pounds do not decline as rapidly as wells working under atmospheric pressure, in the same field. If a pressure of 10–15 lbs. can be put on the wells without affecting production, a large saving in gas which is now wasted will result, and the investigation is therefore of great interest. F. G. P. R.

OIL TANK PROTECTION FROM FIRE BY CORK INSULATION.—*Chem. and Met. Eng.* 1922, **26**, 990.

On Aug. 25, 1921, lightning set fire to a crude oil tank belonging to the Inland Petroleum Co., Pittsburg. The burning oil surrounded a 20 × 25 ft. steel cold-settling tank which was encased in 3 ins. of Nonpareil corkboard, and although the fire raged for three hours the insulating and non-combustible character of the cork kept the temperature of the contained oil (character not stated) below the danger point and no fire occurred. F. G. P. R.

WAXES, OXIDATION OF, TO SOAPS.—H. O. Traun. E.P. 156,141 of March 31, 1922.

Paraffin wax, montan wax, ceresin or the like may be oxidised to fatty acids by heating at a temperature of 120–150° C. under a pressure of at least several atmospheres with air or oxygen in the presence of an alkali. Catalysts such as barium or lead peroxide may be added. Air, purified from carbon dioxide, etc., and preheated to 120–150° C., is continuously blown into the wax contained in a jacketed and heated vessel supplied with a valve set to lift at 3–6 atmospheres. Superheated steam is then passed through for a time, and finally the mixture boiled with water to complete the saponification, which varies from 60–90% of theoretical. F. G. P. R.

HYDROGENATION OF HYDROCARBONS.—Canadian-American Finance and Trading Co. E.P. 174,389.

Hydrocarbon vapours, produced by any means of distillation, are subjected to a pressure higher than that at which distillation has taken place, and at or immediately below the dew-point of the particular

component which it is desired to hydrogenate. Under these conditions hydrogenation and condensation occurs. By employing a plurality of compressors and condensers fractional condensation and hydrogenation of different components in a gaseous mixture can be brought about. F. G. P. R.

HYDROGENATION OF OILS AND FATS.—American Cotton Oil Co. E.P. 175,021 of Feb. 3, 1922.

Oil to be hydrogenated and a catalyst, preferably of finely divided nickel, are introduced into a closed, jacketed receptacle the bottom of which is covered with a tightly fitting slab of porous material, such as Filtros, below which hydrogen is admitted under a pressure sufficient to force its way through the porous plate and prevent any oil flowing down into the hydrogen space. By this means hydrogen is supplied to the oil in the form of infinitely small bubbles which maintain the catalyst uniformly suspended throughout the whole of the liquor, but without causing any frothing. Time of operation and quantity of catalyst necessary are thereby found to be greatly reduced in comparison with usual methods. Several hydrogenating vessels may be connected in series, and excess gas passed from one to the next. F. G. P. R.

TEMPERATURE CONTROLLING DEVICE.—N. H. Freeman. E.P. 175,024 of Feb. 6, 1922 (additional to E.P. 120,590).

A receptacle containing air or other gases, situated within the apparatus of which it is desired to control the temperature, is connected by means of a branched pipe to a vertically inclined tube containing mercury, whilst the open end of the other branch is sealed by dipping below a liquid such as water, both being situated without the heated area. Enlargements are provided in the latter branch to prevent the sealing liquid being drawn back into the gas receptacle by diminution of pressure therein. Expansion of the gas by increase of temperature causes the mercury to rise in the inclined tube and make connection with an electrically operated device for cutting off the source of heat, and conversely contraction of the gas renews the heat supply. The liquid seal on the second branch acts as a safety valve by allowing escape or entrance of gas before undue displacement of the mercury should occur in case of excessive heating or cooling due to a breakdown of the electrical device. A gradual increase or decrease of temperature can be obtained by so setting the depth of the liquid seal that a bubble of gas either escapes from or enters into the gas receptacle at the moment of greatest expansion or contraction of the gas. F. G. P. R.

HYPOCHLORITE SOLUTIONS, APPARATUS FOR PREPARING.—D. McG. Rogers and A. T. Masterman. E.P. 175,390 of Feb. 13, 1922.

The invention relates to an electrolytic cell of improved shape. Carbon plate electrodes, spaced apart by non-conducting distance pieces, are disposed within a box of non-conducting material having no top or bottom, and horizontal openings towards the top in the sides opposite the edges of the electrodes. The latter are arranged in pairs connected alternately to opposite poles, and between adjacent negative and positive faces are perforated plates of non-conducting material. The current

can be reversed at will whereby any deposit on the electrodes is displaced. The cell stands in a bath up to the horizontal openings through which liquor is caused to flow automatically from the bottom upwards.
F. G. P. R.

DRYING OILS, HEAT TREATMENT OF.—R. I. Clark & Co. and J. N. Tervet. E.P. 175,406 of Feb. 15, 1922.

In order to avoid loss of volatile constituents and the risk of fire heat treatment, or cooking of drying oils is carried out in a closed system in a continuous manner. A furnace is provided with a system of pipes through which the oil flows in such a manner that it attains its highest temperature in the last of the series, and is gradually cooled out of contact with air during its passage to the receiver. Thermometer pockets and escape pipes for vapour are provided. F. G. P. R.

OILS AND SOLVENTS, METHOD OF REMOVING SUSPENDED MATTER IN.—H. Hey. E.P. 176,540 of March 16, 1922.

Fine suspensions of water and solid matter are removed from lubricating, extracting and dry-cleaning oils by agitation with sulphonated oils or their alkali compounds either alone or in solution. Such sulphonated oils are produced by the action of sulphuric acid on oleic or ricinoleic acids, their glycerol esters or parent oils. F. G. P. R.

GAS PURIFICATION, ELECTRICAL.—The Lodge Fume Co. E.P. 177,117 of March 23, 1922.

In order to overcome the low conductivity of hot gases in the field of an electrical gas purifier, the gas is cooler to or below its dew-point prior to, or immediately upon, entering the field, and thereafter reheated in such a way as to prevent ionisation through the action of flames or the like. Electrical precipitation of the dry suspended particles then takes place readily. F. G. P. R.

SEPARATING OIL FROM WATER, APPARATUS FOR.—J. H. Palmer. E.P. 177,301 of March 30, 1622.

A rectangular tank is divided into compartments by vertical baffle plates parallel to one another, which alternately extend from the top to within a short distance of the bottom and vice versa. Oil and water are let into the compartment at one end of the tank and traverse an up and down course over and under the baffles to the other end. The distance between the baffles forming the second compartment from the inlet end is substantially greater than that between any other two adjacent baffles, by which means the rate of flow in this chamber is slower than in the others and allows separation of the majority of the oil. Suitable draw-off cocks for oil and water are provided.
F. G. P. R.

HYDROCARBON OILS, PROCESS FOR REMOVAL OF NITROGENOUS SUBSTANCES FROM.—D. T. Day. U.S.P. 1,411,237.

Acid sludge, from the purification of hydrocarbon oils containing nitrogenous compounds, is treated with steam and the weak acid

separated off from the acid tar. This dilute acid, which may be as low as 2–3% strength and is already charged with the majority of the basic nitrogen compounds from the oil, is employed for the removal of similar bodies from still or retort gases by means of a scrubbing tower.
F. G. P. R.

DESULPHURISING PETROLEUM OILS, PROCESS OF.—E. B. Cobb. U.S.P. 1,413,005 of April 18, 1922. (Additional to U.S.P. 1,300,816 of April 15, 1919.

Elementary sulphur is removed from petroleum oils by means of monosulphides of alkali or alkaline earth metals. When sufficient sulphuretted hydrogen is present in the oil it is only necessary to agitate at a temperature of 160–190° F. with alkali hydroxide, whereby monosulphides are formed which combine with elementary sulphur to form polysulphides. If insufficient sulphuretted hydrogen is present it is necessary to add monosulphide as well as hydroxide. F. G. P. R.

ACTIVATED CHARCOAL, APPARATUS FOR MAKING.—T. L. Wheeler. U.S.P. 1,413,146 of April 18, 1922.

The retort is designed for the purpose of dry-distilling organic material and subsequently activating the resulting charcoal in one operation without removing it from the apparatus. The retort is in the form of a horizontal tube of circular cross section having the under side flattened. On the bottom thus formed are laid fire bricks provided with tubular channels extending longitudinally along the retort, and perforations allowing communication between the channels and the interior of the retort. Perforated iron pipes are laid along these channels whereby steam or other reactive gas or vapour can be supplied to the contents of the retort. F. G. P. R.

EVAPORATION OF LIQUIDS, PROCESS AND APPARATUS FOR PREVENTION OF.—F. A. Howard and (*a*) C. I. Robinson. U.S.P. 1,415,351 of Sept. 5, 1922. (Appl. April 12, 1920). (*b*) J. M. Jennings. U.S.P. 1,415,352. (Appl. April 12, 1920). Assignors to Standard Oil Co. of Bayonne, N.J.

(*a*) and (*b*). Volatile liquids stored in the usual type of tank or container are guarded against loss by evaporation by means of maintaining a layer of foam, such as foamite, over the surface of the liquids. Two systems of pipes and apparatus for supplying the foam are described in the two patents. F. G. P. R.

CRACKING.

THE IODINE NUMBERS OF UNSATURATED HYDROCARBONS AND CRACKED GASOLINES.—W. F. Faragher, W. A. Gruse, & F. H. Garner. *J. Ind. Eng. Chem.*, 1921, **13**, 1044.

The authors have investigated the difficulties connected with the accurate determination of the unsaturated constituents of petroleum products with particular reference to the lower boiling fractions resulting from cracking processes. It is pointed out that such data are of interest from the point of view of the derivatives obtainable, and also with regard to the gumming properties of some constituents.

Three methods are usually employed for this determination; *viz.*, Absorption in sulphuric acid, iodine number, and bromine number. The former is perhaps the most common on account of its simplicity, but is undoubtedly the least trustworthy, owing to the complicated nature of the reactions involved with this reagent, sulphonation, polymerisation, solution and oxidation all being known to take place.

Although the iodine value is well established in the case of vegetable and fatty oils, there does not appear to be much literature regarding its use for mineral oils.

Dean, using the Hanus solution and a 30-minutes reaction period, found that the value depended on the quantity of reagent used. Smith and Tuttle also used the Hanus solution and a 30-minutes period, but advocated the use of 1 gm. of oil, incidentally getting very low values.

Radcliffe and Polychronis made comparative experiments, using Hübl, Hanus and Wijs solutions on heavy oils, and found that while the Hanus and Wijs solutions agreed fairly well, all three methods gave increasing values with an increasing period of reaction. The Hubl solution gave a value much below the theoretical for an amylene after two hours, while the Wijs solution gave a satisfactory value. Roderer found, in the case of heavy mineral oils and lignite tar oils, that the Hubl-Waller and Wijs solutions gave maximum values when 5 to 10 times excess of reagent is employed for a period of 16–24 hrs.

Since most of the previous work had been carried out in the heavier fractions of petroleum the authors investigated the effect of Hanus and Wijs solutions on the lower boiling constituents composing cracked gasoline.

In order to note the effect of an excess of bromine two Hanus solutions were prepared, No. 1 containing 12·7 grms. I and 9·0 grms. bromine per litre of glacial acetic acid, and No. 2 containing 12·7 grms. I and 8·0 grms. bromine per litre acetic acid—i.e., the equivalent for a 0·1 N solution of iodine monobromide.

The Wijs' solution contained 8·5 grms. I and 8·6 grms. I Cl per litre glacial acetic acid.

Three samples of commercial spirit were examined :—

(*a*) An unrefined fraction boiling to 150° C. obtained by cracking gas oil at 550° C. and 100 lbs. pressure. This spirit was quite stable on standing.

(*b*) An unrefined fraction boiling to 100° C. obtained by cracking and allowed to stand nine months for separation from polymerised bodies.

(*c*) Unrefined spirit boiling to 150° C. obtained from cracking in the vapour phase.

In addition to these spirits a number of unsaturated hydrocarbons prepared synthetically, were also examined; viz., amylene, isoprene, n. and isohexylene, hexadiene, cyclohexene, cyclohexadiene, heptylene, heptadiene, octylene and cetene.

The procedure adopted and rigidly adhered to throughout these experiments consisted in dropping a small weighing bottle containing the required amount of sample into a reaction flash containing 10 c.c. of carbon tetrachloride. 25 c.c. of the reagent were then introduced and the flask set aside in the dark for the time period chosen. The reaction was then stopped by adding 10 c.c. of 10% pot. iodide solution and 200 c.c. of distilled water and titrating with 0·1N thiosulphate, using starch as an indicator.

Variations were made in the amount of the sample taken, and also in the time period allowed for reaction, and the effects noted by plotting the values obtained against the amount taken per c.c. of reagent, and time in minutes respectively.

A comparison of the iodine numbers of Spirit A and Octylene as obtained by the two Hanus and Wijs' solutions was made, and it was apparent that for quantities less than 0·1 grm. the three solutions gave practically identical results. Hanus No. 1 solution was therefore used for all subsequent determinations.

A series of olefines were examined with variations of the ratio of amount used per c.c. of reagent, and it was observed that as the molecular weight increases the iodine value tends to become a constant quantity within the experimental range. Thus the two amylenes, Trimethylethylene and Methylethylethylene, showed a distinct reduction in the value for an increase in the quantity used, whereas octylene and cetene gave flat curves. This is explained by the fact that for a given weight of olefine the same quantity of reagent will be in much greater excess for a high molecular weight compound.

It was also observed from the curves of the two amylenes, and also the two hexylenes that isomerism had no appreciable influence on the values. Gasolines (*b*) and (*c*) gave quite flat curves.

In the case of diolefines the quantity curve is decidedly steeper, and is quite characteristic for these compounds. The maximum values obtained in the case of hexadiene and isoprene was only 425, whereas the theoretical value for the former is 630, and for the latter 741. This suggests that one double bond of the diolefines is more easily attacked, than the other.

The quantity curve for pure normal heptine is of interest in being flat, and maximum value obtained being only half the theoretical, and seems to indicate that the grouping RCI=CHI is saturated to the Hanus reagent.

Similarly the effect of time allowed for reaction was investigated, and in the case of all the olefines, including straight, branched chain and cyclic compounds the curves were quite flat and indicate that the substitution reaction is negligible. The curves for Gasolines (*a*) and (*b*) showed a very slight increase in value up to the 60 min. point, and then remained constant. As in the quantity curves so in the time curves the diolefine show a distinctive feature, and the presence of these compounds can be qualitatively determined by the iodine value. Working with the Hanus solution as outlined, the values determined in all the classes of hydrocarbons dealt with in no case exceeded the value as calculated from the structure of the compound in question, and indicate an absence of substitution reaction. This also was observed when working with hexane, cyclohexane, benzene and xylene. No connection could be traced, either from the quantity curve or time curve, between the gum forming constituents and the diolefinic content of the gasolines examined. S. B.

CRACKING HYDROCARBONS.—Kansas City Gasoline Co. (Assignees of H. M. Lasher). E.P. 162,269. Feb. 22, 1921. Application 6015-21. Int. Conv. April 23, 1920.

A mass of carbon is suspended on a shelf within an ordinary atmospheric pressure still in such a manner that it is out of contact with any of the heated walls, and yet is immersed in the oil. On distillation taking place the oil circulates around and through the carbon whereby cracking is produced. F. G. P. R.

CRACKING HYDROCARBON OILS—PROCESS AND APPARATUS FOR.—V. L. Emerson. E.P. 163,277 of Feb. 8, 1922.

The process aims at removal of impurities, such as sulphur compounds and water, from the oil before entering the pressure still, and by this means removing danger of corrosion and explosions of water vapour. For this purpose hot oil vapours produced in the tubular pressure still (E.P. 143,217) are forced through oppositely disposed injection nozzles and entrain with them from a reservoir fresh oil containing impurities. Heat is imparted to the oil by the impact of the opposing streams, and by exchange from the hot vapours which are then forced to bubble through the fresh oil reservoir and subsequently led to, condensers. By this means impurities are vapourised and removed, and the purified oil is then injected by a pump into the pressure still in such a manner as to cause circulation of the contents. F. G. P. R.

HYDROCARBON OILS—PROCESS FOR LOWERING VISCOSITY OF.—R. H. Brownlee and C. F. de Ganahl. E.P. 177,589 of March 23, 1922.

By subjecting heavy viscous oils to heat and pressure and at the same time removing any volatile products that may be formed, the viscosity is lowered to a greater degree without substantially affecting the specific gravity, and with greater ease than if the volatile products are not thus removed. The oil is passed through a series of tube stills heated to 675–825° F. and between each still is led through dephlegmators maintained at 450–600° F., where the volatile constituents are removed to condensers and the unvolatilised oil passed on to the next still. Instead of tube stills revolving horizontal cylindrical stills may be employed containing nickel, iron or steel bodies, such as balls or bars, which serve to conduct heat to the oil and keep the still free from carbon deposit.
F. G. P. R.

CRACKING HYDROCARBON OILS—PROCESS OF.—F. A. Kormann. U.S.P. (Reissued) 15,377 of April 18, 1922. (Original U.S.P. 1,332,849 of March 2, 1920.)

Liquid hydrocarbons at a lower temperature than that of the cracking chamber are forced by steam pressure into a mass of porous material contained therein. The liquid being at a lower temperature saturates and cools the porous material, thereby causing contraction and closing of the capillary tubes, which consequently exert pressure on the enclosed oil. The oil is subsequently driven off by superheated steam, and the porous material is again in a heated and expanded condition, ready to receive a fresh charge of cooler oil. Shale clay mixed with bone and willow charcoal forms a suitable porous material. F. G. P. R.

CRACKING SOLVENT NAPHTHA—PROCESS FOR.—F. E. Dodge. U.S.P. 1,409,893.

For the purpose of producing benzol and toluol, solvent naphtha or other high-boiling aromatic hydrocarbons, are introduced into a coking oven (after all oil and gas has been distilled off from the coal), and while the coke is still at a temperature of 600–800° C. The products of cracking are condensed and separated in the usual way and unconverted portions returned to be re-cracked. Special apparatus and auxiliary heating are rendered unnecessary by this means. F. G. P. R.

OIL—APPARATUS FOR CRACKING.—J. B. Edwards. U.S.P. 1,410,173. (Additional to U.S.P. 1,277,883.)

The patent relates to improvements in the means of isolating different parts of the system in a pressure cracking-still in the event of an accident. To the vapour outlet from the still is fitted a valve, kept open by means of a balance weight and light spring, which can be closed by means of a cable operated by hand and then kept in this position by the vapour pressure in the still. In the case of a still having externally heated oil tubes the latter can be isolated by similarly-operated valves closing on the headers connecting the tubes to the still body. F. G. P. R.

LOW-BOILING HYDROCARBONS—PROCESS OF MAKING.—C. M. Alexander. U.S.P. 1,411,255 of April 4, 1922.

Permanent gases from the distillation or cracking of petroleum oils, or natural petroleum gases, are heated to a temperature between 500–1000° C. under heavy pressures of 50–200 lbs. per sq. in. On cooling and condensing low-boiling hydrocarbons suitable for internal-combustion motors are obtained. The higher temperatures and pressure favour formation of aromatic hydrocarbons. Dilution of the gases with uncondensable gas that has already been through the process prevents formation of hydrogen by decomposition of hydrocarbons and thus improves the yield. F. G. P. R.

CRACKING OILS—APPARATUS FOR.—C. P. Dubbs. U.S.P. 1,411,961 of April 4, 1922.

The device consists of a pressure tube-still, composed of two lower headers and one upper one connected by two series of vertical pipes separated by a brick wall, reaching almost to the upper header. Furnace gases thus pass upwards along one series of pipes, over the top of the separating wall and down the second series. Oil is forced into the cooler of the lower headers and flows in counter current to the furnace gases through the system. Vapour is drawn off from the upper header and passes through a cold oil heat exchanger to a water condenser. Unvapourised oil is drawn off from the hotter of the lower headers and returned, together with fresh oil to the cooler end of the still.
F. G. P. R.

CRACKING HYDROCARBON OILS—APPARATUS FOR.—J. Nelson. U.S.P. 1,412,540 of April 11, 1922.

Hydrocarbon oils or their vapours are cracked by being passed through a liquid contact material such as molten lead maintained at the desired temperature. The apparatus consists of a "V" shaped covered tank divided transversely into chambers having communication ports for the passage of the vapours near the cover of the tank. Each chamber has a divisional partition parallel to its vertical sides, extending from the cover to within a short distance of the bottom and having the lower edge serrated and bent in the direction of the gas flow. Liquid contact material fills each chamber to above the level of the divisional partition, the hydrocarbon vapours being forced under pressure to pass below the latter and bubble through the contact liquid from one chamber to the next. In place of the divisional partitions pipes may be used to lead the vapours below the surface of the liquid. By this means there are

no constricted channels at any points where the vapour is exposed to a cracking temperature, and danger from carbon deposition is avoided.

F. G. P. R.

CRACKING HYDROCARBONS—APPARATUS FOR.—H. A. Dreffein. U.S.P. 1,413,327 of April 18, 1922.

In order to overcome the danger of distortion and burning out of cracking apparatus due to intense external heating and internal pressure, the present invention aims at equalising the pressure inside and outside the cracking chamber proper. Within a closed steel vessel lined with fire brick is situated a conical-shaped iron cracking chamber having ports cut in its lower part. To the apex is attached the oil-feed pipe, while the open base rests over a tar sump from which a pipe leads to a condenser and pressure regulating valve. Gas and air are fed through a pipe into the space between the outer vessel and the cone, where combustion takes place and produces cracking of the oil fed into the cone. Owing to the ports in the latter the pressure in the combustion chamber and cracking chamber are equal and the whole strain is taken by the almost cold outer vessel.

F. G. P. R.

CRACKING OILS UNDER PRESSURE.—C. Ellis, assignor to Standard Oil Co., of New Jersey. U.S.P. 1,415,232. May 9, 1922. Application Nov. 26, 1920.

Oil is passed through a series of narrow tubes heated to 400–600° C., and from there is led into a large diameter tube or chamber where exactly the same temperature is maintained. The gaseous products are then led to dephlegmators and fractionally condensed. Super-atmospheric pressure is maintained throughout the system, and water in the form of steam up to 20–50% by volume of the oil may be fed into the cracking tubes with the oil. Secondary decomposition is said to take place in the large chamber, which could not occur in the smaller tubes.

F. G. P. R.

MOTOR FUELS.

THE PHYSICAL PROPERTIES OF MOTOR FUELS.—W. R. Ormandy and E. C. Craven. Institution of Automobile Engineers. Feb., 1922.

An enormous number of mixtures have been proposed for use as motor fuels without regard to their physical characteristics or cost per unit result. The main properties to be considered, both for straight petrol and mixtures, may be classed as: (1) heat of combustion; (2) freezing point; (3) separation point; (4) distillation range; (5) latent heat of evaporation; (6) flash point; (7) explosive range; (8) corrosiveness; (9) viscosity; (10) toluene number; (11) spontaneous ignition temperature. These sections are considered by the authors in detail: (1) Heat of combustion determines the pressure developed, and is therefore of greatest importance in determining the value of the fuel, but other factors may render a fuel with high calorific value less unsuitable for practical purposes than one of lower calorific value. From an engineering standpoint air or oxygen can be regarded as the fuel and the hydrocarbon as the consuming agent, and therefore the amount of fuel (air) is absolutely limited by the size of the engine. Theoretical mixtures of almost any hydrocarbon or alcohol and air give practically the same amount of heat on combustion, and if this were the only factor to be

considered all fuels would be of practically equal value. Change of volume on burning has also to be considered, since this varies greatly with different fuels. (2) Freezing point must naturally be low. Toluene and xylene depress the freezing point of mixtures much more than alcohol, the latter becoming less effective the more water it contains. Paraffins and sulphur-containing bodies also assist. (3) Separation point, in the case of hydrocarbon mixtures, need not be considered as those employed are usually completely miscible at most temperatures. With alcohol, however, the amount of water and the temperature are important factors in mixtures with hydrocarbons, and these are discussed at length by the authors. (4) Distillation range is important, except where chemical individuals such as pure benzol or alcohol are used. Low-boiling fractions give ease in starting or cold engine and high-boiling kerosene-like fractions tend to get into the crank case and reduce the viscosity of the lubricating oil. Ricardo has pointed out that the temperature at which 50% of the fuel has passed over in an Engler distillation is a good guide to its behaviour in an engine. (5) Latent heat of evaporation can be regarded as the amount of heat that must be supplied to the fuel on its way to the cylinder in order that it may be a truly gaseous mixture. For petrols it is about 135 B.T.U. per lb., motor benzols 164, and ethyl alcohol 400. Heating the air is only partially successful, and in practice heating the fuel by the so-called hot-spot manifold gives better results. High latent heat of evaporation is useful in reducing the temperatures of the cylinder walls if the fuel can be introduced in a sufficiently vapourised form. (6) Flash point determines the ease with which starting can be effected, and can be fairly accurately arrived at by multiplying the initial boiling point by a factor—0·736 in the case of the lower flash point, and 0·800 for the higher. At the lower flash point all hydrocarbons have approximately the same vapour tension, and therefore at this point explosive mixtures consist of 1·5% of hydrocarbon vapour, and 98·5% of air by volume. (7) Explosion range with hydrocarbons is on the average :—minimum 1·5%, optimum 2·1%, and maximum 4·2% by volume with air at atmospheric pressure. (8) Corrosiveness due to sulphur compounds is negligible so long as moisture is absent and the sulphur below 1%. Alcohol, however, is oxidisable to acetic acid, with consequent destructive action on metals, but the presence of a small amount of pyridine prevents this. (9) Viscosity varies considerably for different fuels, petrol, benzol and alcohol being as 5, 6 and 11 approximately. This is of importance in a jet carburettor, and makes a great difference to the amount of fuel that will pass through the orifice. (10) Toluene number is an expression employed to denote the tendency of a fuel to detonate—*i.e.*, to cause pinking, at a certain compression. Detonation usually occurs before pre-ignition, the toluene number being highest with pure toluol and lowest with aromatic free petrol. Naphthenic constituents stand a higher compression than paraffin bodies, whilst ethyl alcohol is half again as efficient as toluol. (11) Spontaneous ignition temperature is closely related to the toluene number, and it has been found experimentally that it is lower with paraffins than with aromatics, and increases with molecular weight in both series.

F. G. P. R.

PETROLEUM OILS, SOME CHARACTERISTICS OF, USED ON DIESEL ENGINES.—H. Moore. Diesel Engine Users' Association. April 7, 1922.

The value of analyses of Diesel Engine Fuels is discussed, and the need of correct interpretation of the results obtained. The value of

such tests is much enhanced when the results of various types of oils can be compared and especially when previous behaviour of any particular oil in actual practice is known. The author therefore urges that such data should always be read in conjunction with the analytical constants usually determined.

The relative importance of the various tests usually required are as follows :—

Specific Gravity is generally useful in classifying types and has the merit of easy determination.

Closed Flash Point is only required for fire hazard and is preferable to the open or fire test.

Viscosity.—Although this characteristic varies considerably as between different classes of fuels, it has an important bearing on efficiency of pulverisation and consequent thermal efficiency. The test should be made under a range of temperatures in order to determine whether preheating would be effective.

Cold Test.—This test is of some value in case of paraffin base fuels.

Calorific Value is a fairly constant quantity for all classes of fuels, and is only required for thermal efficiency calculations.

Ash Content, with especial regard to the nature of the ash, in view of possible abrasive action.

Water Content should be low on account of its tendency to collect in pockets rather than being evenly diffused.

Coke Value, as determined by Conradson.

Hard Asphalt is that portion of the oil insoluble in petroleum ether, the quantity of which, to a large extent, determines the value of a fuel for Diesel Engine work. Other things being equal the oil with least hard asphalt will give better results.

A comprehensive table of analyses of all classes of Fuel Oils is given.

S. B.

Casinghead Gasoline ; an Unusual Type of.—C. E. Coates and B. Y. Tims. *J. Ind. Eng. Chem.*. 1922 **14**, 219–220.

The material in question was found to occur as condensate in the gas produced in the Terrebonne Field of South Louisiana. An examination of the crude condensate showed abnormal characteristics, viz., S. G. 0·848 at 24·5° C. ; Ref. Index 1·459 at 17° C. ; distillation range 195° to 226° C. ; strong odour of pine or cedar. The distillate from the crude oil was collected in 2° fractions and these redistilled under reduced pressure and further examined. The purified oil still retained its characteristic odour, even after treatment with C.O.V., and behaved as a saturated compound to bromine. Ultimate analysis, together with calculated molecular refraction, indicated the series as being C_nH_{2n}, the lowest member present being $C_{12}H_{22}$, and believed to be dicyclopentyl.

S. B.

Storage of Inflammable Liquids—Safety Apparatus for.—P. A. P. V. Mauchere. E.P. 154,595 of Feb. 27, 1922.

Additional to and modification of E.P. 144,688 and 153,587. Means are provided for introducing and removing liquid from the storage reservoirs at the same time. An expansion valve is fitted between the gas accumulator and the storage tanks in order to suitably reduce the pressure.

F. G. P. R.

MEASURING PUMPS FOR INFLAMMABLE LIQUIDS.—Compagnie pour la fabrication des compteurs et materiel d'usines a gaz. E.P. 163,316 of March 2, 1922.

The plunger of the pump consists of a piston head to which is attached a flexible accordion pleated cylindrical wall, the other end of which is fastened to the open end of the pump barrel, through which also projects the piston rod. The latter is connected by a rod to a registering device for recording the strokes of the pump. By this means no stuffing-box on the piston rod is necessary, since the accordion pleated wall is gas and liquid tight, and escape of inflammable material is impossible.

F. G. P. R.

GASOLINE PUMP.—M. J. B. Barbarou. E.P. 163,989 of Feb. 23, 1922.

For the purpose of elevating petrol from a tank situated below the level of the carburettor on a motor-car to one above that level, or of feeding petrol direct to the carburettor, the jolting of the car due to unevenness of road surface is made use of to work the pump. The latter consists of a cylindrical barrel fixed in a vertical position to some part of the chassis of the car, or it may be immersed in the lower petrol tank, in which a cylindrical weight of less length is free to slide on a tube centrally situated within the barrel, and extending from the top of the latter to within a short distance of the base. Three valves opening upwards are situated at: (1) the feed pipe at the base of the barrel; (2) at the base of the central tube; and (3) at the lower end of the weight which is suspended on spiral springs above and below. On account of its inertia the weight will rise and fall in the barrel under the influence of road shocks and thus suck petrol through the feed pipe valve, and force it upwards through the valve of the central pipe, which eventually leads to the upper tank.

F. G. P. R.

LIQUID FUEL FOR INTERNAL-COMBUSTION MOTORS.—J. S. Marriott. E.P. 174,463.

A mixture for adding to petrol with the object of increasing the efficiency of the latter is composed as follows:—Alkanet root ($\frac{1}{4}$lb.) is steeped for 12 hours in petrol (1 gal.) and block camphor (4lbs.) then dissolved in the solution, which is finally filtered. A small quantity ($\frac{1}{2}$ to $\frac{1}{5}$ oz.) of this mixture added to a gallon of petrol is said to save consumption of fuel and eliminate deposition of carbon in the combustion chamber.

F. G. P. R.

LIQUID FUEL—MANUFACTURE OF.—C. C. D. Steele. E.P. 174,712 of Feb. 9, 1922.

A fuel for internal-combustion engines is composed of a mixture of petroleum distillate, such as kerosene, naphthaline flake, camphor, benzene, mineral naphtha and wood spirit, to which may be added sulphur, ether, turpentine and liquid ammonia. It is said to have a high calorific value, a cleansing property in the combustion chamber, and act as a lubricant.

F. G. P. R.

MEASURING VOLATILE LIQUIDS—APPARATUS FOR.—D. Bywater. E.P. 174,841.

Two closed vessels of known volume are connected at their upper ends by a pipe fitted at each extremity with a float valve within the vessels. The lower ends are also connected by two pipes, serving for inlet and outlet of the liquid through a central branch pipe, which are each fitted with two valves. A lever, centrally pivoted between these four valves,

opens or closes diagonal pairs of outlet and inlet valves in such a way that there is an intermediate neutral period in which all valves are closed. Thus liquid entering one vessel forces out the contents of the other by vapour pressure through the top connecting pipe until the float valve functions and prevents further entrance. By this means a known volume of liquid is delivered each time the lever is put over either way.
F. G. P. R.

PETROLEUM AND NATURAL GAS—METHOD OF RECOVERY OF.—A. Ehrat. E.P. 175,116 of Feb. 16, 1922.

A combination of bore holes and a mining shaft is employed for the purpose of obtaining crude petroleum oil and natural gas from petroliferous strata. A shaft is sunk outside the oil pool and horizontal galleries are driven up to or below the oil-bearing rock. Bore holes are then driven into the latter from the galleries and the oil and gas withdrawn through pipes. Air under pressure or water may be forced into the oil pool to expel the oil. F. G. P. R.

FUEL—IMPROVEMENTS IN ALCOHOL.—J. Penhale. E.P. 178,373, July 19, 1921. (Application 19,452-21.)

Liquid fuels for internal-combustion engines, consisting chiefly of ethyl alcohol substantially saturated with a hydrocarbon gas such as acetylene, are given increased power by the addition of not more than one per cent. of methyl or ethyl nitrate. F. G. P. R.

FUELS—IMPROVEMENTS IN ALCOHOL.—S. W. Blake. E.P. 178,498, Dec. 16, 1920. (Application 35,447-20.)

A fuel for internal-combustion engines is made by mixing ethyl alcohol of 96% strength (9 gals), acetone (1 gal.) and calcium carbide (3-5 lbs.) in a closed vessel and agitating occasionally during a fortnight. Dissolved lime is removed by agitation with carbon or manganese dioxide. 125 volumes of acetylene are dissolved by the mixture in this manner.
F. G. P. R.

FUEL FOR INTERNAL-COMBUSTION ENGINES.—C. E. Ellis. U.S.P. 1,412,233 of April 11, 1922.

Still gases are passed through strong sulphuric acid and the mixture of hydrocarbons thus absorbed are hydrolysed by water to form alcohols, chiefly iso-propyl alcohol. The aqueous solution is agitated with benzol to extract the alcohols, water separated off and a substantial volume of gasoline added to the benzol-propyl-alcohol mixture. F. G. P. R.

MOTOR FUEL.—E. W. Stevens, assignor to Chemical Fuel Co., of America. U.S.P. 1,414,759, May 2, 1922. Application, March 9, 1920.

A liquid fuel, for internal-combustion engines, of the same general character as petrol, is composed of a mixture of a light distillate from petroleum oil, alcohol a hydrocarbon blending agent and a small amount of a readily volatile ester of formic acid. F. G. P. R.

LIQUIFIABLE CONSTITUENTS OF GASES—METHOD OF EXTRACTING.—E. Schill and F. Woidich. U.S.P. 1,415,058 of May 9, 1922.

Hydrocarbon gases from oil wells, storage tanks, pipe lines, etc., are first compressed to liquify a portion of their constituents and the gaseous portion then expanded in a heat exchanger to further cool the liquid, which is subsequently absorbed in a heavy liquid hydrocarbon. The latter being thus cooled is employed as a cooling medium, and during this process absorbs heat which distils off the light hydrocarbons, which then pass to a cooled dephlegmator. F. G. P. R.

Lubricating Oils.

Mechanical Lubricators.—A. B. Smith. Diesel Engine Users' Association. Feb. 10, 1922.

While recognising that lubricating oil specifications are useful in comparing the physical properties of oils, such information, in view of our present state of knowledge, is somewhat limited in its usefulness owing to the many factors involved. It is equally important to know what particular conditions are likely to be met with in the use of a lubricant such as type and size of engine, speed, temperature and pressures. Having stated these required conditions, responsibility for supplying proper lubricating oil should rest with the oil manufacturer, and the engineer confine himself to the appliances for feeding the oil to the points to be lubricated.

Owing to the higher temperatures, pressures and speeds represented by modern practice, these considerations are of the highest importance. The design and principles of mechanical lubricators are shown diagrammatically with comments in each case. S. B.

Lubricating and Cylinder Oils, Preparation of.—F. C. Thiele. E.P. 154,895 of Feb. 13, 1922.

Crude petroleum oils or residues rich in asphalt or pitch are heated by means of flue gases to 200–300° C. in the presence of hydrosilicates or substances containing hydrosilicic acid in a digester provided with a reflux condenser until the colour is suitably reduced. Lubricating and cylinder oils of excellent quality can then be obtained by distillation with steam in the usual way. F. G. P. R.

Lubricating Oils, Manufacture of.—H. O. Traun. E.P. 156,140 of March 31, 1922.

Cheap tar oils or pitch can be transformed into good lubricating oils of high viscosity by being rapidly passed, with about an equal weight of superheated steam at 300–400° C., through a flattened pipe heated to 500–900° C. The constriction should be about 1 to 3 mm. across, and the time the oil is in the heated area not more than half a minute. The presence of catalysts such as carbon, silicic acid or compounds with heavy and alkaline earth metals, metals and their oxides or alloys especially magnesium compounds are of assistance in the reaction. F. G. P. R.

Lubricating Oil.—H. Langer. E.P. 156,517 of Jan. 5, 1921. (Appl. 409-21). Int. Conv. Aug. 9, 1916.

Lubricating oil emulsions capable of withstanding temperatures up to about 360° C. without burning or depositing carbonaceous matter are made by stirring heavy mineral oils under pressure with 30 to 60% of the total weight of the mixture of saturated lime water. F. G. P. R.

Paraffin Wax and Lubricating Oils from Shale Tars, Process for Obtaining.—E. Erdman. E.P. 156,594 of March 9, 1922.

After removal of lighter portions of the crude oil by distillation with steam the residuum is dissolved in two volumes of acetone, cooled to 0° C., and paraffin wax separated by filtration. The wax is purified by dissolving in an indifferent solvent, treating with concentrated sulphuric acid and after removal of acid sludge precipitated by means of acetone. Lubricating oils are obtained by distilling off the acetone from the wax filtrate and distilling the residual heavy oils with steam or under vacuum. F. G. P. R.

LUBRICATING OILS FROM PEAT TAR, PROCESS FOR OBTAINING.—E. Erdman. E.P. 156,695 of March 9, 1922.

Paraffin wax is first removed by precipitation with acetone (*cf.* E.P. 156,594), and after removal of the solvent the tar is washed with dilute alcohol or acetone (23%) to remove creosote and similar oxygenated compounds. The more volatile constituents are then removed by distillation with steam, or under vacuum, until the viscosity of the residuum is suitably high. F. G. P. R.

HEAVY OIL, PROCESS OF DEHYDRATING.—F. W. Harris. U.S.P. 1,410,673.

Heavy oils containing moisture are mixed with light distillates whereby the viscosity and specific gravity of the mixture are lowered and thus enables the water to be readily separated by electrolytic or other means. The light oil is then distilled off and mixed with a further quantity of wet heavy oil which is raised in temperature by meeting the dried heavy oil from the still in the heat exchanger.
F. G. P. R.

LUBRICATING OILS, PROCESS FOR PRODUCTION OF.—G. D. Harper. U.S.P. 1,414,695 of May 2, 1922. (Appl. May 11, 1918.)

Lubricating oils ready for use without purification by acid and alkali may be produced by concentration of a crude naphthene base petroleum oil, such as Franklin heavy oil, to approximately 70% of its original volume and filtration of the residuum. F. G. P. R.

LUBRICATING OILS, METHOD OF REFINING.—P. T. Sharples. U.S.P (*a*) 1,416,890 and (*b*) 1,416,891 of May 23, 1922.

(*a*) Crude oil is distilled in the usual manner to drive off benzine and kerosene, and the residue which contains paraffin wax in the amorphous state is diluted with about 60% of straight cut naphtha of about 57° Be. The mixture is heated to 100° F. to dissolve all wax and then cooled slowly without stirring to −10° F., after which the wax is separated by treatment in a continuous action centrifugal machine (U.S.P. 1,232,104). The dewaxed heavy oil is then distilled to remove the solvent and light lubricating oils. A bright, heavy, viscous lubricating oil having a low set point is thus obtained without further treatment.

(*b*) Refers to the same form of treatment except that wax in the "intermediate" condition between the "amorphous" and "crystalline" forms is here removed from the oil, which allows of a preliminary non-cracking distillation of the oil to be treated. In this case about 70% of naphtha of 65° Be must generally be used as solvent.
F. G. P. R.

DISTILLATION AND REFINING.

THERMAL PROBLEMS OF PETROLEUM REFINING.—L. A. Mekler. *Chem. and Met. Eng.*, 1922, **26**, 774–8.

In the refining of petroleum the fuel bill is one of the main items of production costs, yet with most stills the thermal efficiency is around 20% as compared with 75–80% in the modern steam boiler. The working range of a still with preheaters incorporated is between 150–450° F., but boiler design cannot be entirely successfully applied owing to great differences in specific heat and chemical constitution between oil and water. The first requirement of a still is "a gradual bringing up of the whole body of oil to the desired temperature at a rate that does

not exceed the thermal capacity of the oil and the heat conductivity of the container." Counter current heating is 42% more efficient than concurrent and avoids local overheating, and capacity is increased by using small tubes and a large volume of low-temperature gases. A coil still with over-fired furnace is superior to a header still in supplying these requirements. The proper mixing of combustion gases in the furnace is of great importance. The best gas and gasified oil burners have a coefficient of 0·9–0·95, while atomising low-pressure oil burners seldom exceed 0·8, and high-pressure ones still less. Nozzle velocity should just exceed the velocity of propogation of flame of the particular fuel used, and complete combustion should have taken place before the gases enter the heating zone. The design of the combustion chamber is of great importance, and for each temperature there is a fixed ratio between the combustion space and the amount of fuel burned almost independent of the character of the latter. The circulation of the combusted gases is very beneficial in producing even heating. Curves and tables are given to illustrate the points under consideration. The author concludes with a plea for pooling of experiences in order to raise the standard of operating efficiency. F. G. P. R.

WOLDICH RECTIFYING TOWER PROCESS.—V. B. Guthrie. *Nat. Pet. News*, 1922, **14**. No. 7, 34, 37–8.

Crude oil from a pre-heater passes to a topping tower and thence, with a certain added amount of a light hydrocarbon, to a pipe still. From here the mixture passes through a series of refining towers maintained at constant, but successively lower, temperatures, where different fractions are condensed and withdrawn. The preliminary addition of light hydrocarbons first saturates the unsaturated hydrocarbons forming unstable molecules, which then break down to smaller molecules without formation of carbon. By a process of substitution sulphur and nitrogen compounds are broken up with elimination of the two elements. The condensed products require no further treatment. F. G. P. R.

EFFICIENCY OF OIL-REFINING APPARATUS.—*Chem. and Met. Eng.*, 1922, **26**, 784.

The U.S. Bureau of Mines are conducting at Bartlesville a study of the efficiency of oil refining equipment. Most refineries were erected when oil was cheap, and quick return of capital was considered before efficiency. Changed conditions have in consequence forced many refineries to shut down. Progressive refiners realize that the present method of treating distillates are often unsatisfactory, and work is to be done to determine the proper method of treating production from each type of crude oil. The use of open-top agitators results in large evaporation losses and will form another subject for investigation. F. G. P. R.

FATS AND OILS—APPARATUS FOR REFINING.—P. Parodi. E.P. 153,579 of Feb. 6, 1922.

A vertical shaft capable of being rotated and carrying a series of perforated trays is situated in a circular casing, in which are fitted stationary perforated trays alternating with those rotating. A casing of larger diameter surrounds the upper part of the apparatus, and between the two casings are also annular perforated trays. The lower part of the inner casing and shaft is surrounded by a closed receiver connected also to the outer casing, containing a draw-off cock and a closed steam heating coil. Melted fats or oils to be purified are introduced near the head of the inner casing, and in descending meet a current of steam introduced

near the bottom. The revolving and stationary trays cause a thorough mixing of oil wtih steam which carries off impurities through an outlet at the top of the casing. Moisture from the receiver passes off between the two casings, where any oil is trapped by the annular trays and returned to the receiver. F. G. P. R.

STILL.—Chemische Fabriken Worms Akt.-Ges. E.P. 157,849 of Feb. 2, 1922.

In stills constructed on the principle of a fire tube steam boiler it is undesirable to have an end tube plate when high-boiling materials such as tar are being distilled. In order to overcome this objection the flue tube is introduced into one side of the boiler and following a " U "-shaped course emerges at the opposite side. A battery of stills can be constructed in such a way that flue gases pass from one still to another, and thus fractional distillation may be brought about. F. G. P. R.

HEATING MATERIALS AT SUCCESSIVELY DIFFERENT TEMPERATURES.—Thermal Industrial and Chemical Research Co. E.P. 174,690 of Jan. 20, 1922.

A series of closed baths containing molten metal, such as lead, are arranged along the horizontal flue of a furnace, so that those nearer the fire are at a higher temperature than those more remote. A drum of cylindrical or polygonal cross-section and capable of being rotated is partly immersed in the molten metal of each bath, the whole series of which latter are interconnected by pipes between the spaces above the metal. Vapour pipes leading to condensers are also fitted to the covers of each bath. Material to be heated is introduced into the coolest bath above the drum, which, by revolving takes the material beneath the surface of the molten metal. The material is thus subjected to successive increases of temperature as it passes from one bath to the next and fractional distillation takes place. F. G. P. R.

TAR STILLS—IMPROVEMENT IN CONSTRUCTION OF.—C. Benn, C. H. Benn & C. L. Benn. E.P. 174,877.

In the ordinary dome-bottomed pot-shaped tar still the rivetted edge where the bottom joins the vertical sides is particularly subject to attack by flames and flue gases. In order to overcome this the bottom is constructed with a downwardly turning anular flange, which is rivetted to a correspondingly lengthened side of the still and the rivetted portion embedded in the brick setting. Where the flue of the fireplace occurs an iron protecting shoe may be clamped over the projecting rivetted flange, or the downwardly-turning flange of the still bottom may be turned up at this position and rivetted to the side. F. G. P. R.

DISTILLING OILS—IMPROVEMENTS IN APPARATUS FOR.—The Power Speciality Co. E.P. 176,099 of Feb. 27, 1922.

The patent relates to improvements in the construction of tube stills. Two banks of horizontal tubes are arranged in a furnace on either side of a brick arch, so that the flue gases pass up through the first bank and down through the second. The tubes in each bank are connected in series, and the top series of the second bank is connected to the bottom one of the first bank. Oil is pumped in at the bottom of the second and cooler bank and thus flows upwards in counter-current to the flue gases during the preheating period, but in the first bank or distilling period the

oil and flue gases flow upwards together. The tube may be supported centrally by a brick arch. F. G. P. R.

DISTILLING OILS—IMPROVEMENTS IN APPARATUS FOR.—The Power Speciality Co. E.P. 176,100 of Feb. 27, 1922.

A tube still is so arranged that the cold oil is first pumped through tubes embedded in the brick roof or wall of the hottest part of the furnace and then through banks of horizontal tubes always in counter current direction to that of the flue gases. Each bank of tubes is provided with a vapour outlet capable of being closed by a float valve, operated by a rise in the level of the oil. Vapour pressure will then force away any obstruction to free flow of oil through the tubes. Dampers are provided for by passing heat from any bank of tubes. F. G. P. R.

DISTILLING OIL—IMPROVEMENTS IN APPARATUS FOR.—The Power Specialty Co. E.P. 176,101 of Feb. 27, 1922.

A tube still, as described in E.P. 176,099, is provided at the exit end with a separator where unvolatilised oil is freed from vapour and returned by means of a pump to the still at the point of juncture of the two banks of tubes. Pressure can be maintained in the still by means of a valve in the vapour line prior to the separator. F. G. P. R.

DISTILLING OIL—IMPROVEMENTS IN APPARATUS FOR.—The Power Specialty Co. E.P. 176,102 of Feb. 27, 1922.

In a tube still as described in E.P. 176,100 each bank of tubes is provided with a vapour separator and means of returning unvolatilised oil to the next hotter bank. Should any obstruction to free flow of oil through the tubes occur a float valve, operated by the banking up of the liquid, closes the vapour exit, and increasing pressure will force away the obstruction. Fractional distillation is thus obtained. F. G. P. R.

PRESSURE DISTILLATION—APPARATUS FOR CONTINUOUS.—E. M. Clark. U.S.P. 1,410,797.

A bench of pressure stills, operated according to U.S.P. 1,132,163, are interconnected through their vapour lines as well as through a common liquid draw-off line, the vapour pressure and level of liquid being thus maintained equal in all stills. A constant volume of hot liquid is continuously forced by the still pressure through the common draw-off line to atmospheric-pressure tar stills where any desired amount is distilled off and returned to the pressure-stills feed tank. The feed to the pressure-stills is maintained by means of a pump, and is regulated to be equal to the distillate and tar withdrawn to tar stills. Owing to reduction of pressure the tar contains sufficient heat to largely distil of its own accord, but may be assisted by live steam and external heating.

F. G. P. R.

DISTILLATION OF LIQUIDS—APPARATUS FOR.—J. L. Major. U.S.P. 1,415,667 of May 9, 1922.

In any form of still the liquid is introduced through a system of pipes which enter through the top and pass downwards to the bottom thereof, and thence through a series of coils to pipes leading upwards to a tray having serrated edges situated above the normal level of the liquid in the still. By this means the entering liquid is warmed up to distillation

temperature without coming into actual contact with the liquid in the still, and is ready to disengage its lighter vapours at the moment of flowing over the serrated edges of the tray. The higher boiling liquors in the still may be passed on to another more highly heated still in the same manner and thus fractional distillation brought about.

F. G. P. R.

CONTINUOUS PETROLEUM REFINING APPARATUS.—C. A. Jouett. U.S.P. 1,415,876. May 16, 1922.

The still proper consists of a vertical cylindrical tower, divided horizontally into a number of chambers, which is surrounded concentrically by a flue having ports opposite each chamber through which hot furnace gases may be admitted from a stack. Thus each chamber can be heated to any desired temperature, irrespective of the rest, and means are provided for admitting steam thereto. Preheated oil is sprayed into the top chamber and the unvapourised portion flows through an annular trap to a spraying device at the top of the second chamber, and so on through the series. Vapours from each chamber are led to superimposed dephlegmators and thence through a tower containing a solid filtering medium to condensers. Condensates from the dephlegmators and filter chambers run back to a lower and hotter chamber of the still and are there again vapourised.

F. G. P. R.

OIL SHALES AND COALS.

THE RELATION OF SHALE-OIL RESIDUE TO OTHER BITUMENS.—C. W. Botkin. *Chem. and Met. Eng.*, 1922, **26**, 445–8.

In a former article (*Chem. and Met. Eng.* **26**, 398) the properties of heavy residuum from Colorado and Utah shale oils were shown to resemble those of better known and more widely used bitumens, and the present paper is the result of a closer study of that resemblance. Gilsonite proved to be almost identical to "shale-oil residues" in properties and products of destructive distillation. Asphalt yielded less oil and a lower percentage of "additional saturates" on destructive distillation, whilst rosin formed an equal quantity of the latter to that obtained from crude shale oil, but the distribution of the saturates in the oil fractions was the reverse to that formed in "shale-oil residues." Shale-oil bitumen more closely resembles gilsonite than asphalt, grahamite or petroleum residues. Saturates are not present as such in any of the above substances, but one produced by decomposition during destructive distillation.

F. G. P. R.

PEAT, THE CARBONISATION OF, IN VERTICAL GAS RETORTS.—Fuel Research Board. *Technical Paper No.* 4.

The Report deals with the first series of experiments carried out with peat obtained from Turraun and containing 17–20% of water.

In the first experiment carbonisation was carried out at 1000° C. with 6% of steam, that quantity being just sufficient to quench the coke before extraction. Under these conditions the volume of gas evolved was considerable and difficult to deal with, and a second experiment was made at a temperature of 800–900° C., maintaining the throughput at 6 tons per day. After supplying heat for carbonisation there were for disposal from each ton of peat 7940 cub. ft. of gas of 325 B.T.U., 12·6 gallons of tar, 95·5 gallons of liquor, and 5·4 cwt. of charcoal.

TAR OIL FROM TEST No. 2.

Fraction 0–170° C. :—			
Gallons per 100 gallons of tar	2.52		
Sp. Gr.	0.863		
Loss by extraction with C.O.V.	13.2%		
,, ,, 10% NaOH..	40.5%		
Refined Spirit Distillation—			
Sp. Gr.	0.804		
First drop	80° C.		
Vol. to 120° C.	12.2%		
120–130° C.	6.1		
130–150° C.	25.4		
150–170° C	19.6		
Fraction 170–230° C. :—			
Gallons per 100 gallons of tar	13.8		
Sp. Gr.	0.957		
Loss by extraction with C.O.V.	54.0		
,, ,, 10% NaOH	8.0		
Refined oil distillation—			
Vol. to 180° C.	15.7	Sp. Gr.	.800
180–200° C.	25.6	,,	.870
200–230° C.	19.6		
	60.9	,,	.900
Fraction 230–270° C.—			
Gallons per 100 gallons tar	13.8		
Sp. Gr.	0.950		
Loss by extraction with 10% NaOH	9.0%		
Distillation— to–230° C.	52.5%	Sp. Gr.	.955
230–250° C.	21.2		.930
250–270° C.	10.8		.900
	84.5		

Other tables showing yields, temperature and pressures, analyses of peat, gases, charcoal and liquor, are given. The Report is obtainable at H.M. Stationery Office, Imperial House, Kingsway, W.C. 2. S. B.

PITCH COKE—DETERMINATION OF VOLATILE COMBUSTIBLE MATTER IN.—H. E. Lloyd and F. W. Yeager. *J. Ind. Eng. Chem.*, 1922, **14**, 220–222.

Since the efficiency of Pitch Coke for the manufacture of electrodes demands a low content of volatile matter, the accuracy of this determination has become a matter of great importance.

The existing methods are examined in detail and sources of errors indicated. These errors are particularly noticeable in the case of pitch coke where the volatile matter is comparatively low are and mainly due to oxidation of the non-volatile portion of the coke. The method adopted is a modification of the A.S.T.M. method, using a smaller crucible of 10 c.c. capacity with a tight-fitting lid and taking 2 gms. instead of 1 gm.

The crucible is heated at 950° C. in an electric furnace for two intermittent 7-minute periods and the loss of weight obtained by the second heating deducted from the loss obtained by the first heating. The results obtained after this correction are found to approximate very closely to results obtained by heating in an inert gas. S. B.

CHARACTERISTICS OF LOW-TEMPERATURE COAL TAR.—J. J. Morgan and R. P. Soule. *Chem. and Met. Eng.*, 1922, **26**.

Low-temperature tar was compared with coke oven and gas works tars and statistics of physical properties given. These values are notably lower for low-temperature tars, but fractionation curves of all are very similar.

Phenols from low-temperature tars increase with the yield of tar from the coal carbonised, the non-phenolic oils remaining constant. Nitrogen bases are 80% tertiary and 20% secondary, both showing unsaturation, but without any preponderant compound. Pyridine was detected in the first fraction, but the higher boiling bases differ from those from coal tar in having lower specific gravities and higher molecular weights ascribed to the presence of partly hydrogenated nuclei and longer side chains. Alcohols and carbon disulphide are not present, but hydrogen sulphide is found in the lowest fraction. The neutral oils have low specific gravities and viscosities, and only traces of compounds solid above −30° C. No single hydrocarbon predominates. Unsaturated hydrocarbons are present and can be separated by 98% H SO_4 or liquid SO_3. They belong to the same series of cyclic compounds found in Pictel's "vacuum tar." Solid aromatic hydrocarbons are absent and only traces of liquid ones could be detected. F. G. P. R.

SOLID FUEL—TREATMENT OF—FOR TRANSPORTATION.—L. W. Bates. E.P. 154,605 of March 30, 1922.

Carbonaceous material such as coal, lignite, etc. is ground to pass 95% through a 100-mesh screen and 85% through a 200 mesh. Ash is removed by any known wet or dry method and up to 30% of the carbonaceous particles are combined with "fixated" liquid hydrocarbon by heating or agitation or a combination of the two. "Fixated" liquid hydrocarbons are produced by adding small amounts of soaps, alkalis or liquid coal-tar derivatives to the hydrocarbons, which are then capable of holding carbonaceous particles in suspension for long periods without sedimentation, and thus enable their transportation through pipes. F. G. P. R.

COAL DISTILLATION PRODUCTS—MANUFACTURE OF.—E. Fleischer. E.P. 154,938 of March 7, 1922.

A combustible gas as free as possible from steam and carbonic acid, and having a temperature of over 900° C. is continuously introduced into the base of a gas-producer charged with coal from above, while at the same time air and steam are injected into an upper section in such quantity that the gases thereby burnt will only attain a temperature of 600–800° C. The cooler upper zone is suitable for distilling liquid products and ammonia, while the hotter lower zone produces thoroughly degassed coke. F. G. P. R.

SULPHUR PREPARATIONS OF THIOPHENE SERIES—MANUFACTURE OF.—H. Scheibler. E.P. 155,259 of March 13, 1922.

Tar oil obtained from bituminous rocks is heated to boiling with solid alkali hydroxides alone or with addition of oxides of alkaline earths, such as soda-lime. The unacted on oil is distilled off and washed with dilute mineral acid to remove basic compounds, after which it is treated at 100° C. with alkyl-magnesium halogenides washed with water and soda-lye solution, and heated to boiling with metallic sodium, and finally distilled off. The product thus obtained is colourless, or only slightly coloured, and without the objectionable odour of the usual commercial medicinal article. F. G. P. R.

SULPHUR PREPARATIONS FROM BITUMINOUS-ROCK OIL.—H. Scheibler. E.P. 155,546 of March 17, 1922.

Tar oils rich in sulphur which have already been treated with alkali hydroxides with the addition of alkaline earths according to E.P. 155,259 are further purified by treatment with metallic sodium, sodium, amide or sodium and gaseous ammonia at a temperature of 100–120° C. for several hours. The oil is then distilled off under reduced pressure (about 15 m.m.) in the presence of a passive gas up to a vapour temperature of 240° C.
F. G. P. R.

UNSATURATED HYDROCARBONS—EXTRACTION FROM CARBONACEOUS MATERIAL.—H. O. Traun. E.P. 156,123 of March 30, 1922.

A solution of sulphur dioxide in acetone or higher ketones is employed as a solvent of unsaturated hydrocarbons which occur in coals, lignites, etc. It can also be used for extracting unsaturated compounds from liquid or gaseous mixtures with saturated hydrocarbons. The operation may be carried out at ordinary or increased pressures, but better results are obtained with the latter. Temperatures between 0–15° C. are found convenient.
F. G. P. R.

MONTAN WAX—EXTRACTION OF . . . FROM BITUMINOUS COAL.—H. O. Traun. E.P. 156,138 of March 31, 1922.

Bituminous coal containing montan wax, after disintegration, is mixed with water, to which small quantities of an emulsifying agent, such as alkali soaps and a solvent for the wax may be added, and emulsified by means of a fast running disintegrator kept warm by steam coils. The emulsified wax and coal is then filtered from sand by means of a press and coagulated by heating or the addition of an electrolyte. After settling the coagulated mud may be treated with a wax solvent or distilled with superheated hydrocarbon vapours with or without the addition of steam, by which means the wax is separated from the finely-divided coal.
F. G. P. R.

PARAFFIN WAX FROM SHALE TARS—APPARATUS FOR OBTAINING.—E. Erdmann. E.P. 156,693 of March 30, 1922. (Additional to E.P. 156,594.)

Paraffin wax is precipitated from shale and lignite tars by the addition of acetone. In order to avoid loss of solvent a completely closed system is employed, comprising a mixer, cooler, filter-press and still. Means are provided for washing the wax in the press with clean acetone and with water.
F. G. P. R.

LIGNITE AND SHALE TARS—TREATMENT OF.—E. Erdmann. Eng. Pat. 156,694, Jan. 7, 1921. (Application 728-21.) (Int. Conv. Sept. 2, 1919.) Additional to E.P. 156,594.

Crude tars are first treated with acetone and the insoluble paraffin wax separated off. Sufficient water is then added to the acetone solution to cause separation of the viscous lubricating oils, whilst creosote oils remain dissolved in the aqueous acetone. By this means lubricating oils are obtained free from injurious phenolic compounds.
F. G. P. R.

SATURATOR FOR TREATING GASES WITH LIQUID.—Carl Still Co. E.P. 157,223 of March 23, 1922.

A device, chiefly for the manufacture of ammonium sulphate by the action of sulphuric acid on distillation gases, in which the gas is led at high velocity through a small opening in one end of a large diameter pipe, the other end of which has a serrated edge and dips below the

liquor to be saturated. By this means a cone of gas is made to pass through the pipe and incrustations of solid material on the inner walls, with consequent blocking of the pipes, is avoided. F. G. P. R.

DISTILLING COAL TAR—APPARATUS FOR.—C. Ab-Der-Halden. E.P. 158,875, Jan. 24, 1921. (Application 2,998-21.) (Int. Conv. Feb. 9, 1920.

Tar is continuously distilled by the aid of superheated steam from a still provided with a continuous overflow run out. On the still is mounted a dephlegmator connected at its upper end with a heat-exchange condenser by means of two pipes. Cold fresh tar passing through the heat exchanger is deprived of its moisture, and flowing through the lower of the two pipes into the dephlegmator meets the stream of ascending vapours from the still. Moisture from the fresh tar passes into the dephlegmator by the upper pipe and is carried with the distilled vapours by way of a heavy oil catch pot to the heat-exchange condenser, and thence to water condensers. F. G. P. R.

FUELS—METHOD OF STORING COMPOSITE MOBILE.—L. W. Bates. E.P. 159,173, Jan. 5, 1921. (Application 482-21.) (Int. Conv. Feb. 19, 1920.)

Mobile fuels comprising particles of solid carbonaceous matter and liquid hydrocarbons are cooled until they become a non-mobile paste, covered with water to act as a seal, and maintained at a low temperature until required. By this means deposition of solid matter is prevented. Before use heat is applied to restore the mobile condition.

F. G. P. R.

CARBONACEOUS MATERIAL—TREATMENT OF.—W. E. Trent. E.P. 159,497 of Feb. 16, 1922. (Additional to E.P. 151,236 of April 15, 1920.)

Finely-divided carbonaceous material suspended in water is agglomerated by means of hydrocarbon oil or the like, according to the earlier patent and distilled. By this means the agglomerating material is recovered and can be used over again, and at the same time volatile constituents of the coal or carbonaceous material are obtained and useful hard coke produced. The still or retort consists of a coiled pipe within a chamber heated internally by flue gases, the agglomerated material being thinned with more oil, and then forced through the pipe by air or gas pressure. Vapours and coke dust pass through a collecting chamber for the latter and thence to condensers. F. G. P. R.

BITUMINOUS SUBSTANCES—PROCESS FOR VOLATILISING AND DECOMPOSING.—Canadian-American Finance and Trading Co. E.P. 174,965 of Feb. 9, 1922. (Additional to E.P. 169,763.)

Hydrocarbon substances, such as tar-sands, are where necessary, crushed and graded and heated by enclosed steam or fire to flow point. The fluid mass is then substantially instantaneously vapourised by admixture with sufficient superheated steam to volatilise the whole of the hydrocarbons, the sand drawn off through a water-cooled trap and the vapours fractionally condensed in scrubbing towers. The latter are provided with means of adding superheated steam in any particular section and thus producing cracking of the vapours. Cooling coils are also provided in the scrubbers. F. G. P. R.

COAL—METHOD OF CARBONISING.—G. P. Lewis. E.P. 175,670 of Feb. 28, 1922.

Carbonaceous material, such as coal, lignite, peat, etc., is finely powdered, mixed with liquid hydrocarbons and passed through tubes under a pressure and temperature not exceeding 25 atmospheres and 500° C.

respectively. The vapourised portion is condensed and the unvolatilised part made into briquettes. Lime and boric acid may be added to the material to neutralise acidic substance and prevent clogging in the tubes. F. G. P. R.

PLANT COMPRISING FUEL DISTILLATION AND STEAM POWER—IMPROVEMENTS IN.—Merz and McLennan. E.P. 175,800 of March 2, 1922.

Exhaust steam from a steam-power unit is superheated and passed through a low-temperature fuel distillation apparatus, from which the hot gases and steam pass through heat exchangers and evaporate make-up water. The clean make-up steam thus produced is introduced into the power plant at a stage when the pressure is substantially equal to that of the make-up steam. F. G. P. R.

SOLID FUEL AND TAR DISTILLATION—MANUFACTURE OF.—W. W. Strafford. E.P. 176,822 of March 16, 1922.

Finely-ground solid carbonaceous material such as anthracite, coke, etc., is mixed with a compound of barium, preferably the carbonate, charcoal and sufficient tar to bind the mixture into a briquette and retorted at a temperature of 400–1000° C. A solid smokeless fuel of high calorific value which ignites readily is obtained. F. G. P. R.

RETORT FOR SHALE.—G. A. Bronder and T. Costigan. E.P. 176,847 of March 15, 1922.

The retort comprises a vertical cylinder containing the charge of shale and a smaller multi-tubular cylinder for the purpose of heating the retort gases, which are then returned by means of a blower to the retort. The gases are heated by an auxiliary gas burner and supply the heat required for distilling the shale. F. G. P. R.

GAS—DEVICE FOR COLLECTING FROM RETORTS.—C. Carpenter. E.P. 176,891 of March 15, 1922.

In order to seal or unseal at will the dip pipes in hydraulic mains from gas retorts an airtight container, attached to a vacuum line, is joined to the mains. By opening the valves on the vacuum lines liquor is withdrawn from the mains into the container and the dip pipes unsealed. Releasing the vacuum reverses the process. F. G. P. R.

RETORTING SOLID HYDROCARBON-CONTAINING MATERIALS.—N.V. S. Knibbs. E.P. 178,157 of Dec. 7, 1920. (Application 34,555-20.)

Hydrocarbon oils, etc. are distilled from shales, coal, lignite and the like by causing the material to traverse a vertically inclined rotary retort of the cement-burning type in such a manner that the non-volatile carbonaceous matter is burnt in a regulated supply of air in the lower portion of the retort, and thus supplies hot gases to produce distillation of the volatile constituents in the upper end. Combustion may alternatively take place in a separate furnace outside the retort and may also be assisted by the addition of fixed gases from the distillation. F. G. P. R.

BINDING OR PRESERVING AGENTS—BITUMINOUS COMPOUNDS FOR USE AS.—F. Lamplough. E.P. 178,558. (Application 2467-21.)

Bituminous material such as mineral pitch is passed through a confined space, for example, a coil heated to 200–500° C. Petroleum oils or water may be admitted with the bituminous material. The resulting product does not become brittle in cold or liquid in warm weather, and is therefore very suitable for use as a binder in the manufacture of coal briquettes.

The latter are improved in heating value by being mixed with lime water and dried at a temperature of 115–120° C., before addition of the binder, in order to remove moisture and some of the ammonia. Unsaturated hydrocarbons may be added to the bituminous material and the mixture passed through a cracking temperature of 600° C., in order to produce a quick drying material suitable for preservative coatings for building materials. F. G. P. R.

PARAFFIN OR OTHER LIQUIDS—APPARATUS FOR EVAPORATING.—F. S. Cripps and R. J. Milbourne. E.P. 178,734 of May 9, 1921. (Application 13,116-21.)

In order to mix paraffin hydrocarbon vapours or those of other liquids with coal gas for the purpose of preventing deposition of naphthaline in gas mains, the liquid is made to flow down a spiral or helical shelf attached to a vertical hollow shaft heated internally by hot flue gases. The shaft is positioned centrally within a chamber of large diameter having horizontal baffles so placed that coal gas admitted towards the bottom of the chamber has to pass alternately next to the shaft and sides of the chamber on its way to the exit at the top. In this manner thorough mixing of gas and oil vapours is ensured. The spiral shelf is inclined downwards towards the shaft in order to prevent liquid dripping off the edge and to keep it in contact with the hot flue. F. G. P. R.

RETORTS—STEAM DEVICE ADAPTABLE TO ROTARY.—J. W. H. Randall. U.S.P. 1,413,779 of April 25, 1922.

The device is applicable to any known form of rotary retort employed for the purpose of distilling oil-shales, coal and the like, in which it is advantageous to pass steam through the mass of the material. A series of perforated pipes are attached to the inner surface of the retort, preferably parallel to its longitudinal axis, and are connected through valves placed on the outside to a common header running circumferentially round the inner surface of the retort. This header is joined to a pipe situated axially which is connected through a rotating joint with the main steam supply from without. On the valves between the perforated pipes and the header are projecting arms for opening and closing the valves, which action is brought about automatically by means of trip-bars so situated that each valve is opened in turn as soon as the perforated pipe connected therewith becomes buried in the shale by the rotation of the retort, and is similarly closed when the pipe becomes freed. By this means only those pipes which are covered by material in the retort admit steam, which is thus forced to penetrate the mass and perform work in the most useful and economical manner. F. G. P. R.

TAR-APPARATUS FOR DISTILLING.—C. Schaer. U.S.P. 1,415,056 of May 9, 1922.

Two cylindrical stills are set at different levels in order to provide means of continuous fractional distillation. Through the centre of the stills runs a rotating shaft bearing scoops or ladles which spread the tar over the walls of the stills and thus enable more rapid vapourisation to take place. F. G. P. R.

DEHYDRATION OF PYRIDINE.—W. J. Huff, Assr. to Koppers Co. U.S.P. (A) 1,416,205 and (B) 1,416,206. May 16, 1922. (Application Jan. 27, 1921.

(A) Water-containing pyridine is dehydrated by distilling off a fraction, which serves as a vehicle to carry off water, removing water from

this distillate and returning it to the still, till the required degree of dehydration is attained. (B) A low boiling point liquid is added to water-containing pyridine in an amount less than that required to form a binary constant boiling point mixture with all of the water. The low boiling point liquid serves as a vehicle to carry off water. The mixture is distilled and the liquid added till the desired degree of dehydration is attained. H. M.

EXTRACTION OF SMALL QUANTITIES OF LIQUID BY THE SOXHLET APPARATUS.—H. Handorf. *Z. angew. Chem.*, 1922, **35**, 257–258. (G.P.'s. 807,757 and 809,512.)

A glass vessel is inserted in the ordinary Soxhlet apparatus. In the case in which a liquid is extracted by a solvent lighter than itself (for instance, ether), this vessel has above it a funnel, the stem of which extends to the bottom of the vessel and ends in a rose. The liquid to be extracted is placed in the vessel and is covered by a layer of the solvent. The condensed solvent drops into the funnel, emerges in fine drops from the rose, and rises through the liquid to be extracted. In the case of a liquid being extracted by a solvent heavier than itself (for instance, chloroform), a short funnel ending in a capillary rests on the top of the vessel, and the vessel is provided with a tube which opens near the bottom and passes through its wall at a suitable height. The condensed solvent in this case falls in drops through the liquid to be extracted and passes through the tube to the outside of the vessel. In each case the passage of the solvent in drops through the liquid effectually mixes the latter. The apparatus is suited for the extraction of colloidal liquids and serums. Tables show that quantative extracted was attained in from three to twelve hours. H. M.

COMPOSITION OF PEAT TAR AND SHALE TAR.—J. Marcusson and M. Picard. *Petroleum*, 1922, **18**, 637–638.

The destructive distillation of peat, carried on at Elisabethfehn, yields 2½–5% tar, from which may be obtained 15–26% light oil, 20–40% middle oil, 10–20% creosote oil, 2–7% paraffin, and 10–20% pitch residue and gases. On digesting peat tar with ether there remained 3% insoluble residue, forming a black mass, consisting of oxyacids and their esters, and salts of iron and calcium. The ether solution was freed from bases by treatment with hydrochloric acid, saponified with alcoholic solution of potash, and separated by the Spitz and Hönig method. The unsaponifiable portion contained 8% on the tar of solids, which were separated by acetone at −20° C. and had an iodine value of 26·3 and an acetyl value of 31. The saponified solution, treated with hydrocholic acid, deposited 24·5% of dark brown acid substances, and when these were digested with ether 3% of dark oxyacids remained undissolved, and the evaporated extract treated with hot benzine left 8% of insoluble oxyacids of lower m.p. than those insoluble in ether. 11·5% of matter soluble in benzine consisted of a mixture of fatty acids of high molecular weight with phenols. Shale tars were tested by a similar method. Both shale and peat tars gave 16–22% of fatty and oxyacids, principally in the form of calcium salts, and 5% of basic substances. H. M.